TM-1020 Series Progressive Scan Shutter Cameras

Operation Manual

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Rev. B

PULNiX
Imaging Products

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The TM-1020 series cameras have been certified to conform to the requirements of Council Directive 89/336/EC for electromagnetic compatibility and to comply with the following European Standards:

Immunity: EN50082-2/1995
Emissions: EN55011/EN61326-1, Class A

All PULNiX products bearing the CE mark have been declared to be in conformance with the applicable EEC Council Directives. However, certain factory-installed options or customer-requested modifications may compromise electromagnetic compatibility and prohibit use of the CE mark. Please note that the use of interconnect cables that are not properly grounded and shielded may affect CE compliance.

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This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his own expense.

WARNING

Changes or modifications to this unit not expressly approved by the party responsible for FCC compliance could void the user's authority to operate the equipment.

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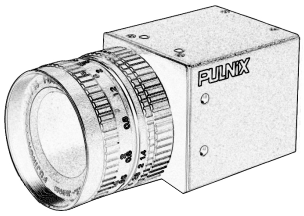


1 Introduction

1.1 Product Description

The PULNiX TM-1020 series[1] consists of high-resolution, high-speed monochrome progressive scan CCD cameras. The interline-type CCD permits full vertical and horizontal resolution of very high speed shutter images and applications. The electronic shutter, which has speeds to 1/16,000 sec., can be reset asynchronously by external pulse control. The base model's frame rate is 15 fps. A square imager format with uniform square pixels provides superior image definition in any orientation. On-chip micro lenses provide increased sensitivity.

The TM-1020 series has a full dynamic range control function, which can be set at externally selectable look-up table (LUT) knee slopes to convert 10-bit input to 8-bit output, thereby optimizing the CCD's full dynamic range in the normal output signal range. The camera has an 8-bit, RS-422 or RS-644 digital signal output for interfacing with external image-processing systems. All the key functions are externally controlled via RS-232C. The CL models have a Camera Link output.

Multi-camera operation requires synchronized data and clock phases from each camera. The TM-1020 series has a pixel clock locking phase lock loop (PLL) for multi-camera operation that is offered as an option. [2]

Applications for the TM-1020 series include machine vision, medical imaging, intelligent transportation systems, high-definition graphics, on-line inspection, gauging, character reading, archiving, and high-security surveillance.

1. Unless specifically mentioned, all information in this manual is relevant to all released cameras in the TM-1020 series, including TM-1020-15, TM-1020A and all variations, Camera Link versions (CL), FW version, and the TM-1020-30 and CL.
2. Pixel clock locking option not available at time of publishing. Please check with PULNiX for option availability.

1.2 Features

- **Miniaturized and lightweight**

  The printed circuit boards in the TM-1020 series have been arranged based on a new design philosophy. This creates modular electronics for the camera, giving it flexibility. In addition, the use of miniature solid-state components results in a compact, lightweight camera that is 44mm x 44mm x 64mm in dimensions, and weighs only 149 grams.

- **Imager**

  The TM-1020 series uses a progressive-scan interline transfer CCD that has the following features:

  - Resolution of 1008 x 1018 active pixels for excellent image quality.
  - 9.0 x 9.0 µm square pixels for precise dimensional measurement.
  - High-speed electronic shutter capability for high dynamic resolution of moving objects and electronic iris control that eliminates the need for a mechanical shutter.
  - Progressive-scan CCD eliminates interlace deterioration of image and increases ease of computer interface.
  - High sensitivity and low noise at fast scanning. The 1" CCD has an excellent S/N ratio that is greater than 50dB.
  - The CCD has a built-in microlens for increased quantum efficiency.

- **Electronic shutter**

  The TM-1020 series has a substrate drain-type shutter mechanism which provides superb pictures at various speeds without smearing. A built-in manual shutter speed control selects the electronic shutter rate of 1/60 (non-async mode only), 1/125, 1/250, 1/500, 1/1,000, 1/2,000, 1/4,000, 1/8,000, or 1/16,000 second.

  With VINIT high (5V), the CCD keeps discharging. With a negative pulse to VINIT, the camera resets and purges the charge momentarily. Then it starts integrating for the period of shutter control set by either an external pulse width or internal shutter control. Progressive scanning permits a full 1000 lines of vertical resolution, as compared to a conventional CCD camera which captures only half the vertical lines per shutter.

- **Asynchronous reset**

  The TM-1020 series captures async reset images and provides single-shot video output with single FDV. This makes it simpler for an ordinary frame grabber to capture the async reset images. The TM-1020 series's asynchronous reset is flexible and accepts external horizontal drive (HD) for phase locking. When the VINIT (5V) pulse is applied, it resets the camera's scanning and purging of the CCD.

  The TM-1020A-15 has two modes to control the asynchronous reset and shutter speed:

  - **External VINIT with pulse width**. The duration between pulse edges controls the shutter speed externally (No-delay shutter).
  - **Internal shutter speed control**. The speed control varies from 1/125 to 1/16,000 sec. The video signal and FDV starts with internal V reset timing related to shutter speed.

  The TM-1020-15 has three modes to control the asynchronous reset and shutter speed:

  - **External VINIT with pulse width**. The duration between pulse edges controls the shutter speed externally.
  - **Internal shutter speed with Fast mode**. The video signal has no delay from the reset timing. (shutter speed range is 1/2,000 to 1/16,000 sec.)

- **Internal shutter speed with Slow mode**. The speed control varies from 1/125 to 1/1,000 sec. The video signal starts with internal V reset timing related to shutter speed.

- **Output**

  The TM-1020 series has an 8-bit RS-644 digital output for interfacing with external image-processing systems (TM-1020-15 is RS-422 only) with RS-644 digital output available as an option. Camera Link models are designated by the letters "CL" at the end of the camera name. Please contact your PULNiX representative for details on these options and models. The analog output is 1.0 Vp-p composite video (75Ω) on all models.

- **Integration**

  The TM-1020 series is capable of capturing high-resolution integration images. Its CCD imager can be exposed for longer than the normal scan timing of 1/15 sec. This integration feature provides extra sensitivity for applications in dark environments. The progressive scan imager permits a full frame of resolution in non-interlace format. Integration is achieved by pulling pin #11 of the 12-pin connector to low (GND) for the frames to be integrated.

- **Three-Year Warranty**

  The CCD solid-state image sensor allows the camera to maintain a superior performance level indefinitely while requiring virtually no maintenance. PULNiX backs all of the TM-series cameras with a three-year warranty.

  Warning: Unscrewing the camera cover or opening the camera in any way will void this warranty unless prior written approval is obtained from the factory.

1.3 Functional Options

- RS-644 (LVDS/RS-422) output.
- Adjustable back-focus front end for the TM-1020 series (including Camera Link versions).

1.4 System Configuration

FIGURE 1. TM-1020 Series System Configuration

Figure 1 below presents a typical system configuration for the LVDS/RS-422 version.

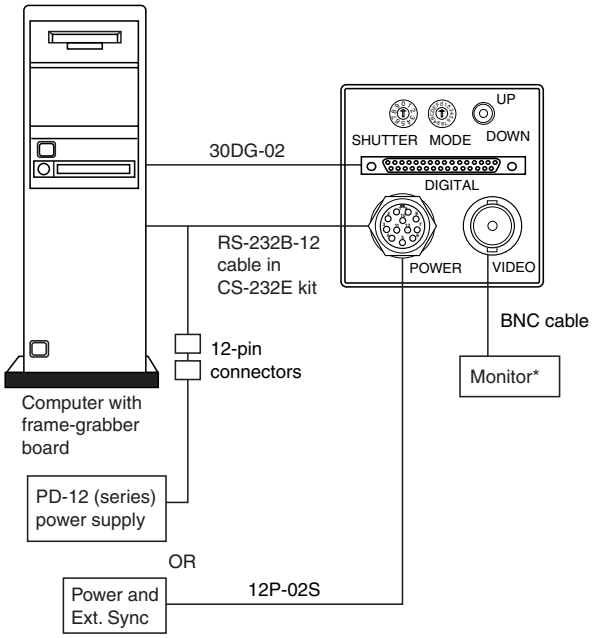
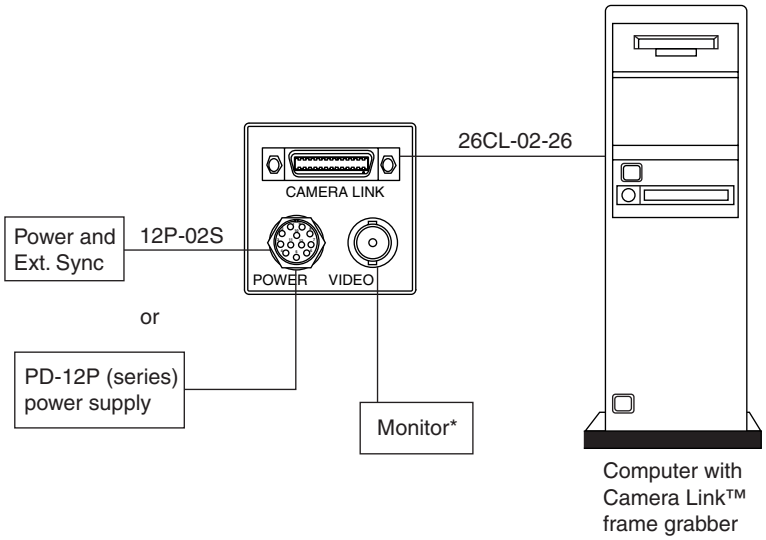


FIGURE 2. CL (Camera Link) System Configuration

Figure 2 below presents a typical system configuration for the Camera Link version.



*PULNiX PVM-942 or PVM-1242 monitor can be used with camera in two-row binning mode.

2 Installation

The following instructions are provided to help you to set up your camera quickly and easily. We suggest that you read through these instructions before you unpack and set up your camera system.

2.1 Getting Started

2.1.1 Unpacking Instructions

We recommend that you save the original packing cartons for the cameras and accessories in case you need to return or exchange an item.

We also recommend that you bench-test any equipment being sent to another location for field installation to assure that everything is fully operational as a system.

2.1.2 Components List

Please begin by checking your order against the Components List shown below to assure that you have received everything as ordered, and that nothing has been overlooked in the packing materials. If any item is missing, please contact your PULNiX representative immediately.

- TM-1020 series camera
- Camera-specific data sheet
- Camera-appropriate operation manual (if ordered)

2.1.3 Accessories and Options

Following is a list of additional accessories and options that may be required for your application. Please check with your PULNiX representative before you install your camera to determine what you might need.

- Digital output cable 30DG-02
- Serial Communication Kit CS-232E
- PD-12U series power supply
- 12P-02S power cable
- 26CL-02-26 Camera Link cable (for TM-1020 Camera Link models)

2.2 Camera Setup

2.2.1 Heat Dissipation

The TM-1020 series camera from PULNiX America, Inc., is a compact 1K by 1K camera. Since all the electronics have been packed in a compact package, the outer case of the camera gets hot due to heat

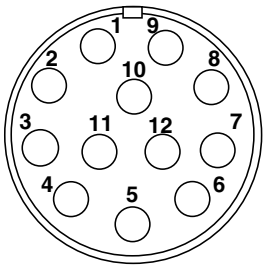
dissipation. For optimal performance, PULNiX recommends using a cooling fan to set up a positive air flow around the camera and following the precautions below.

- Mount the camera on a large heat sink (camera bracket) made out of conductive material like aluminum.
- Make sure the flow of heat from the camera case to the bracket is not blocked by a non-conductive material like plastic.
- Make sure the camera has enough open space around it to facilitate the free flow of air.

Please contact PULNiX America, Inc. at (800) 445-5444 or send an email to imaging@pulnix.com if you have any questions.

2.2.2 Connector Pin Configurations

2.2.2 (a) 12-Pin Connector (LVDS/RS-422 version)



The TM-1020 series has a 12-pin Hirose connector for power input, serial communication, and signal integration. Pin #1 is Ground and Pin #2 is +12V DC. Other pins handle a number of input and output functions, as shown in Table 1 below.

TABLE 1. 12-Pin Connector (LVDS/RS-422 version)

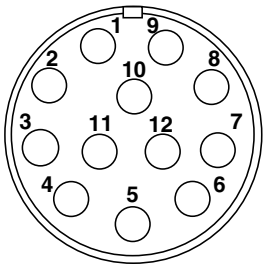
Pin	Description	Pin	Description
1	GND (power)	7	VD In
2	+12V DC	8	Strobe Out
3	GND (analog)	9	HD In
4	Video Out	10	RXD (RS-232)
5	GND (digital)	11	Integration Control
6	VINIT In	12	TXD (RS-232)

2.2.2 (b) 12-Pin Connector (Camera Link Version)

The CL versions have a 12-pin Hirose connector for power input and signal integration. Pin #1 is Ground and pin #12 is +12V DC. The pin-out table is shown below. For TM-1020-15CL, serial communication camera control is done via the Camera Link connector on the rear panel of the camera.

TABLE 2. 12-Pin Connector (CL Version)

Pin	Description	Pin	Description
1	GND	7	VD in
2	+12V DC	8	Strobe out
3	GND (analog)	9	HD in
4	Video out	10	N/C
5	GND (digital)	11	Integration Control
6	VINIT in	12	N/C



2.2.2 (c) Digital Output Connector (LVDS/RS-422 only)

The LVDS/RS-422 version has a 31-pin AirBorn connector (MP211-031-113-4300) on the rear panel to output 8-bit, RS-644 video data. The TM-1020-15 is 8-bit, RS-422 video data. The connector pin-out is shown in the figure below.

FIGURE 3. Rear Panel View of Digital Connector

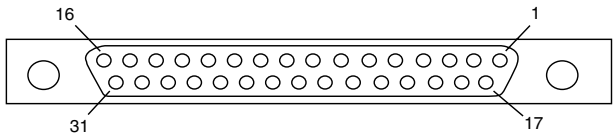


TABLE 3. 31-Pin Connector (MP211-031-113-4300)[1]

Pin#	Description	I/O	Pin #	Description	I/O
1	CLK+	Out	17	CLK-	Out
2	LDV+	Out	18	LDV-	Out
3	FDV+	Out	19	FDV-	Out
4	GND		20	VINIT [INTEG	In In]
5	EXT HD (TTL) [EXT CLK+	In In]	21	[EXT VD (TTL) [EXT CLK-	 In]
6	INTEG [HD+	In In]	22	N/C [HD-	 In]
7	N/C [Vinit+/(VD+)	 In	23	GND [Vinit-/(VD-)	 In]
8	D0+	Out	24	D0-	Out
9	D1+	Out	25	D1-	Out
10	D2+	Out	26	D2-	Out
11	D3+	Out	27	D3-	Out
12	D4+	Out	28	D4-	Out
13	D5+	Out	29	D5-	Out
14	D6+	Out	30	D6-	Out
15	D7+	Out	31	D7-	Out
16	GND				

1. Note: CLK: data clock; LDV: Line Data Valid; FDV: Frame Data Valid; INTEG: Integration control; EXT CLK: External pixel clock; [ ]: Differential input option.

The CL version has a 26-pin connector on the rear panel to output Camera Link data. The connector pin-out is shown in Table 4 on page 9.

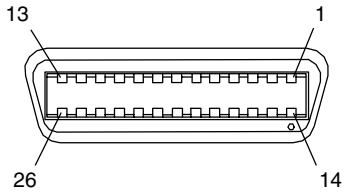


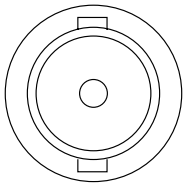
TABLE 4. Connector and Pin-out Configurations

Camera Link Connector					
Pin #	**Description**	**I/O**	**Pin #**	**Description**	**I/O**
1	GND		14	GND	(Shield)
2	Tx OUT 0-	Out	15	Tx OUT 0+	Out
3	Tx OUT 1-	Out	16	Tx OUT 1+	Out
4	Tx OUT 2-	Out	17	Tx OUT 2+	Out
5	Tx CLK OUT -	Out	18	Tx CLK OUT+	Out
6	Tx OUT 3-	Out	19	Tx OUT 3+	Out
7	SerTC+	In	20	SerTC-	In (LVDS/RS-422 or RS-232)
8	SerTFG-	Out	21	SerTFG+	Out
9	VINIT-	In	22	VINIT+	In
10	INTEG+	In	23	INTEG-	In
11	N/C		24	N/C	
12	N/C		25	N/C	
13	GND		26	GND	

Note: SerTC: Serial To Camera
SerTFG: Serial to Frame Grabber

2.2.2 (d) Analog Output Connector

The TM-1020 series has a BNC connector on the rear panel to output analog video data. See Section 2.2.4 on page 10 for additional information on analog video output.



2.2.3 Shutter Speed Control Dial (LVDS/RS-422 version)

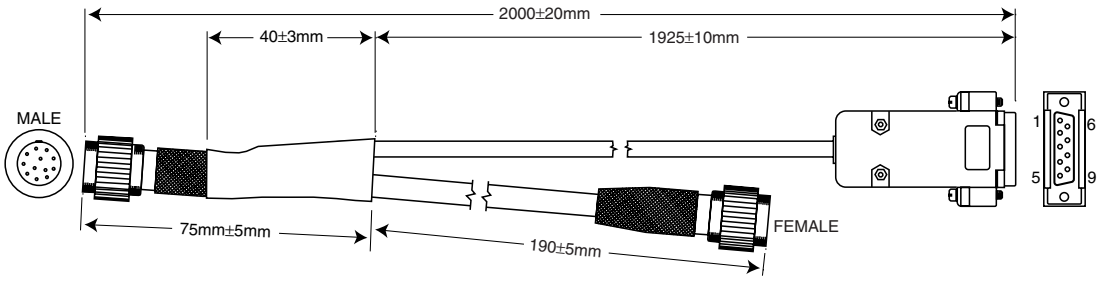
Shutter speed can be selected by switching the shutter dial to the appropriate setting (0 through 9). The factory default settings correspond to the shutter speeds as shown in Table 5 below.

TABLE 5. Shutter Speed Control Dial

	Manual	Async
0	no shutter	no shutter
1	1/60	1/16,000
2	1/125	1/8,000
3	1/250	1/4,000
4	1/500	1/2,000
5	1/1000	1/1,000
6	1/2,000	1/500
7	1/4,000	1/250
8	1/8,000	1/125
9	1/16,000	Ext. pulse-width control

2.2.4 RS-232 Communication Cable (LVDS/RS-422 version)

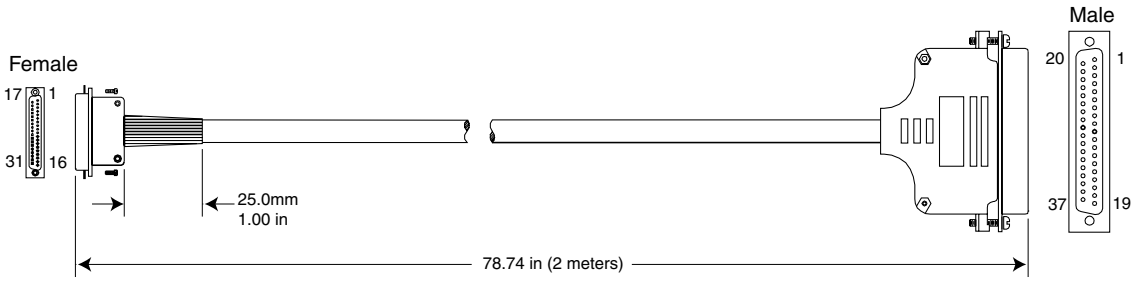
FIGURE 4. Serial Communication Cable RS-232B-12



The RS-232 controller set CS-232E includes the RS-232B-12 interface cable, software disk, and a quick-start card. The TM-1020 (RS-422 and LVDS/RS-422 version) camera's built-in look-up table (LUT) can be controlled by an external RS-232 interface. The camera settings can be programmed or changed using the communication cable and software. Commands from the RS-232 interface will over-write the rear panel switch settings of the camera. Please refer to the AccuPiXEL Series Camera-Control Software manual for details on the graphical user interface.

2.2.5 Digital Output Cable (LVDS/RS-422 version)

FIGURE 5. Digital Output Cable 30DG-02



The TM-1020 series camera uses the cable 30DG-02 from PULNiX as a digital output cable. This cable has a 31-pin AirBorn connector on the camera end and a 37-pin D-sub male connector on the other end. Contact your PULNiX representative regarding availability of interface cables for specific frame grabber models. Pin-out configuration for the digital cable is shown below.

FIGURE 6. Pin-out Configuration for Digital Output Cable

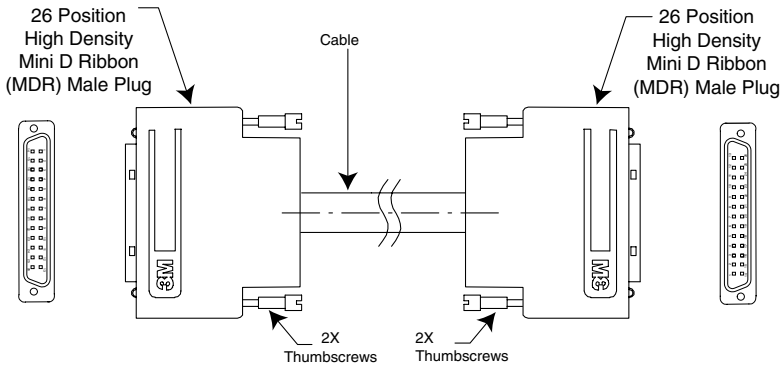
FROM 31 PIN CONN	**TO** 37 PIN CONN	**WIRE COLOR**
PIN 1	PIN 1	OR 1RED
PIN 2	PIN 2	GRY 1RED
PIN 3	PIN 3	WHT 1RED
PIN 4 GND	PIN 16 GND	YLW 1RED
PIN 5 HD		PINK 1RED
PIN 6 INTEG		OR 2RED
PIN 7 PULSE		GRY 2RED
PIN 8	PIN 8	WHT 2RED
PIN 9	PIN 9	YLW 2RED
PIN 10	PIN 10	PINK 2RED
PIN 11	PIN 11	OR 3RED
PIN 12	PIN 12	GRY 3RED
PIN 13	PIN 13	WHT 3RED
PIN 14	PIN 14	YEL 3RED
PIN 15	PIN 15	PINK 3RED
PIN 16 NC		
PIN 17	PIN 20	OR 1BLU
PIN 18	PIN 21	GRY 1BLU
PIN 19	PIN 22	WHT 1BLU
PIN 20	PIN 17	YEL 1BLU

FROM 31 PIN CONN)	**TO** 37 PIN CONN	**WIRE COLOR**
PIN 21 VD		PIN 1BLU
PIN 22 EN/INTEG		OR 2BLU
PIN 23 GND	PIN 23 GND	GRY 2BLU
PIN 24	PIN 27	WHT 2BLU
PIN 25	PIN 28	YLW 2BLU
PIN 26	PIN 29	PINK 2BLU
PIN 27	PIN 30	OR 3BLU
PIN 28	PIN 31	GRY 3BLU
PIN 29	PIN 32	WHT 3BLU
PIN 30	PIN 33	YLW 3BLU
PIN 31	PIN 34	PINK 3BLU
	PIN 35 GND	SHIELD
	N/C PINS 4, 5, 6, 7 18,19, 24, 25,26, 36, AND 37	

2.2.6 Camera Link Cable (CL Versions Only)

The 26CL-02-26 cable assembly has been standardized as the Camera Link cable. This cable has a 26-pin connector on both ends. This is a straight-through cable and the pin-out configuration is shown in Table 4 on page 9. Contact PULNiX for cable lengths other than 2 meters.

FIGURE 7. 3M Camera Link Cable



Note: *For CL versions, serial communication for camera control is done via the Camera Link connector on the rear panel of the camera.*

2.2.7 Power Supplies and Power Cable Setup

2.2.7 (a) Power Supplies

The TM-1020 series camera requires 12V DC power that is obtained through the 12-pin connector located on the rear panel of the camera. PULNiX recommends the following power supplies:

K25-12	110V AC/12V DC	2.1A power supply (OEM type)
K50-12	110V AC/12V DC	4.2A power supply (OEM type)
PD-12UU	100-240V AC/12V DC	1.2A universal voltage power supply, US Plug
PD-12UUP	PD-12UU with12-pin connector	US plug
PD-12UE	PD-12UU	European plug
PD-12UEP	PD-12UU with 12-pin connector	European plug

For users providing power through the 12-pin connector, the PD-12P, PD-12UEP and PD-12UUP power supplies are available with the 12-pin mating connector already attached to the leads from the power supply. The PD-12UU and PD-12UE power supplies can be connected to the PULNiX power cable via a terminal strip or directly.

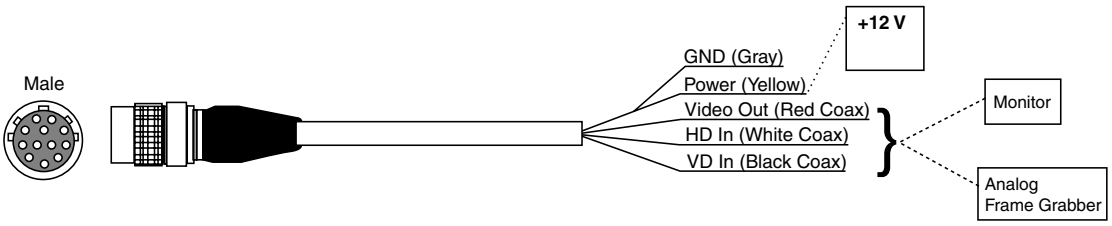
When wiring the PD-12UU and PD-12UE power supplies directly, please note the following:

- The lead ends must be twisted together and tin-soldered for strength and electrical continuity.
- Shrink tubing or a similar insulator should be used to prevent exposed leads from touching and shorting.
- The +12V lead is marked with a red stripe or white lettering; be sure not to reverse the leads.
- All connections must be properly insulated to prevent shorting.

2.2.7 (b) PULNiX Power Cables

If you are using PULNiX power cables such as the 12P-02S, please refer to the 12-pin connector pin-out diagram in “12-Pin Connector (LVDS/RS-422 version)” on page 6. The cable pin-out diagram is shown in Figure 8 below. The color-coded leads use Gray for Ground and Yellow for +12V.

FIGURE 8. 12P-02S Interface Cable (optional)



12P-02S Interface Cable					
Pin#	**Lead Color**	**Function**	**Pin#**	**Lead Color**	**Function**
1	Gray	GND	7	Black coax	VD Input
2	Yellow	+12V DC	8	White coax shield	Strobe out
3	Red coax shield	GND	9	White coax	HD Input
4	Red coax	Video Out	10	Brown	RXD (RS-232)
5	Orange coax shield	GND	11	Blue	Integration
6	Orange coax	VINIT IN	12	Black coax shield	TXD (RS-232)

Note: *Make sure that the unused leads are not touching and that there is no possibility that exposed wires could cause the leads to short.*

2.2.7 (c) "K" Series Power Supplies

The "K" series power supplies are designed primarily for OEM users who will be mounting the power supply inside a protective enclosure. For use in exposed situations, the PD-12 series power supplies are recommended.

1. Attach the 110V line cord to the two terminals marked "AC." Do not plug the cord into a 110V AC socket until later in the procedure.
2. Attach the Gray and Yellow leads of the power cable to the Ground and 12V DC terminals, respectively.
3. Replace the plastic terminal guard on the power supply.

2.2.7 (d) Building Your Own Power Cable

Refer to the 12-pin connector pin-out in Section 2.2.2 (a on page 6. Connect the Ground lead to pin #1, and the +12V DC lead to pin #2 of the 12-pin connector. Power must be DC-regulated, and of sufficient current to properly power the camera.

2.2.7 (e) Attaching the Power Cable to the Connector

The 12-pin connector is keyed and will only fit in one orientation. Follow these directions to properly attach the power cable to the camera connector:

1. Rotate the connector while applying slight pressure until the keyways line up.
2. Press the connector into place until firmly seated.

3. Plug the power cord into the 100V AC socket. This will power the camera up.

2.2.8 Attaching the Analog Video Output

When connecting the TM-1020 series to an analog frame grabber or a monitor, use the BNC connector on the rear panel of the camera. The input of the monitor should be balanced for 75Ω termination. Standard RG-59 type coaxial cable should carry a full video signal for up to 500 feet. The TM-1020 series has a two-row binning mode that can be used to display real-time images on PULNiX's PVM-942 or PVM-1242 monitors. These monitors are specially modified to accept a 30Hz progressive scan image.

The multi-conductor cable 12P-02S from PULNiX can be used to transmit analog video, power, sync. signals, and serial communication. The mini coaxial leads in PULNiX multi-conductor cables are designed for short runs of no longer than 100 feet.

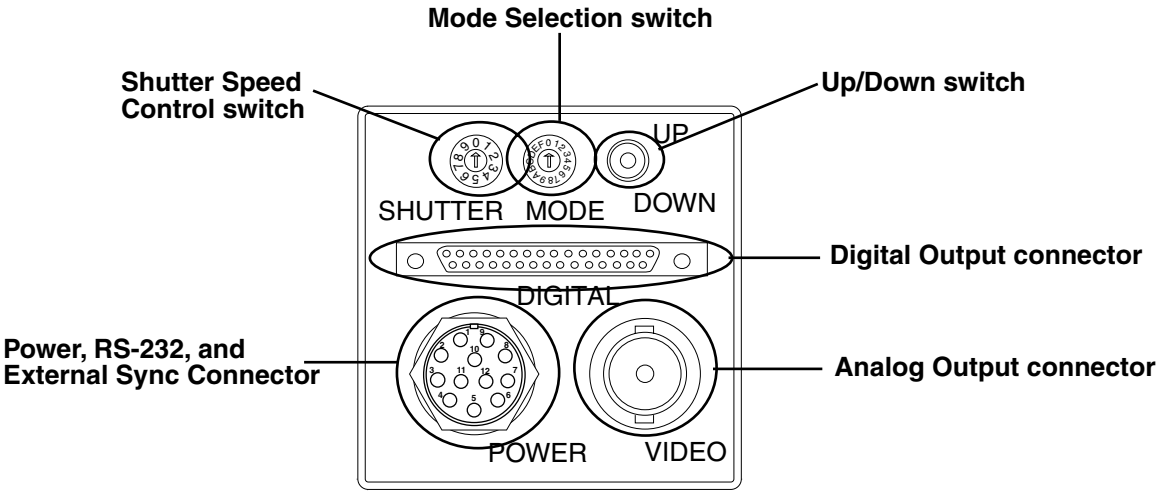
Note: *Make sure that no extraneous wires are visible which could cause a short.*

2.2.9 Attaching the Camera Lens

The TM-1020 series camera accepts 1" or larger format size C-mount lenses. To attach the C-mount lens to the camera, carefully engage the threads and rotate the lens clockwise until it firmly seats on the mounting ring. Do not force the lens if it does not seat properly. Please note that some lenses with extremely long flangebacks may exceed the mounting depth of the camera.

3 Operation

3.1 Camera Rear Panel (LVDS/RS-422 Version)



3.1.1 Up/Down Switch

The Mode Selection switch works in conjunction with the Up/Down switch. Refer to Table 6 above for information on the Up/Down switch.

3.1.2 Digital Output Connector

Refer to Section 2.2.5 on page 11 for information on the digital output connector.

3.1.3 Analog Output Connector

The LVDS-version cameras has a BNC connector on the rear panel to output analog video data.

3.1.4 Power, RS-232, and External Sync Connector

Refer to Section 2.2.2 (a on page 6 for information on the power, RS-232, and external sync connector.

3.1.5 Shutter Speed Control Switch

Please refer to Section 2.2.3 on page 10 for information on the Shutter Speed Control dial. The factory default settings correspond to the shutter speeds as shown in Table 5 on page 10.

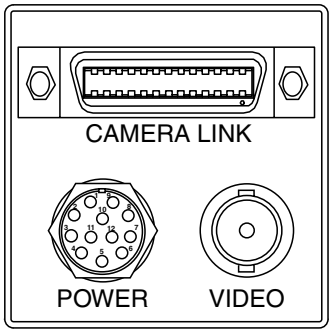
3.1.6 Mode Selection Switch

Various modes can be implemented with the rear panel Mode Selection switch. The Mode Selection switch works in conjunction with the Up/Down switch and RS-232 external control. Commands from the RS-232 interface will over-write the rear panel switch settings of the camera. The table below shows details on various modes.

TABLE 6. Mode Selection Switch

Mode Selection Switch Position	Mode Information	Up/Down Switch	Functions
0	Normal Mode	Display Mode (D)	
1	Set Gain	Up/Down	Change gain
2	Set Vtop (A/D)	Up/Down	Change A/D ref. top
3	Set Vbottom(A/D)	Up/Down	Change A/D ref. bottom
4	Gain Selection #1	Up: 9dB, Down: 12dB	Lower gain selection
5	Gain Selection #2	Up: 18dB, Down: 22dB	Higher gain selection
6	Linear LUT	Up: Linear, Down: LUT	Linear/LUT selection
7	Knee Selection	Up/Down (Scroll)	Scroll 10 different LUTs
8	Async Reset Mode	Up: Normal, Down: Async	Async and normal shutter
9	Factory default Recall	Up/Down: Recall	Factory setting
A	Power up Setting	Up: Recall, Down: Save	Power up page setting
B	User Page Storage #1	Up: Recall, Down: Save	User page storage setting
C	User Page Storage #2	Up: Recall, Down: Save	User page storage setting
D	Direct Shutter Control	Up/Down	Shutter speed increment by 1H
E	Scan Format2	Up: Optional, Down: Binning	Two-row binning selection
F	Scan Format1	Up: Normal, Down: Normal	Custom option scanning

3.2 Camera Rear Panel (CL Versions)



3.2.1 Digital Output Connector

Refer to Section 2.2.6 on page 11 for information on digital output connectors.

3.2.2 Analog Output Connector

The CL-version camera has a BNC connector on the rear panel to output analog video data.

3.2.3 Power and External Sync Connector

Refer to Section 2.2.2 (b on page 7 for information on the power and external sync. connectors.

3.3 Progressive Scanning

Standard TV-system scanning is 525 lines interlace scanning as specified in the RS-170 protocol. Every other horizontal line (odd lines and even lines) is scanned at a 60Hz rate per field, and the scanning is completed with two fields (one frame) at 30Hz rate. Because of the interlace scanning, the vertical resolution of CCD cameras is limited at 350 TV lines, regardless of the horizontal resolution. When electronic shutter is applied, the CCD can hold only one field of charge at each exposure. Therefore, the vertical resolution of the electronic-shutter camera is only 244 TV lines. The situation is the same for an HDTV-format camera, since it has interlaced scanning and the vertical resolution of the shuttered image is 500 lines.

The TM-1020 series uses a state-of-the-art progressive scanning interline transfer CCD which scans all lines sequentially from top to bottom at one frame rate. Like a non-interlace computer screen, it generates a stable, crisp image without alternating lines and provides full vertical TV resolution of 1000 lines (a normal TV monitor display may not be able to show 1000 lines due to monitor resolution of 30Hz scanning).

The interline transfer architecture is also important to generate simultaneous shuttering. This is different from full frame transfer architecture which requires a mechanical shutter or strobe light in order to freeze the object motion.

The TM-1020 series outputs the progressive-scanned image with an electronic shutter in two different formats:

1. Progressive-scanning digital and analog output

   The CCD signal goes through A/D and D/A converters and through 10-bit in, 8-bit out look-up table (LUT).

   The analog output is the same as 75Ω, 1Vp-p format available from BNC and 12-pin connector. The digital output is available from 31-pin connector (RS-422 or RS-644) or Camera Link connector.

2. Double-speed scanning output (display output)

   By selection, the two-row binning mode puts double-speed video for monitor display. It repeats twice from one frame of input video. Refer to Section 3.8 on page 27 for information on scan modes.

3.4 Electronic Shutter

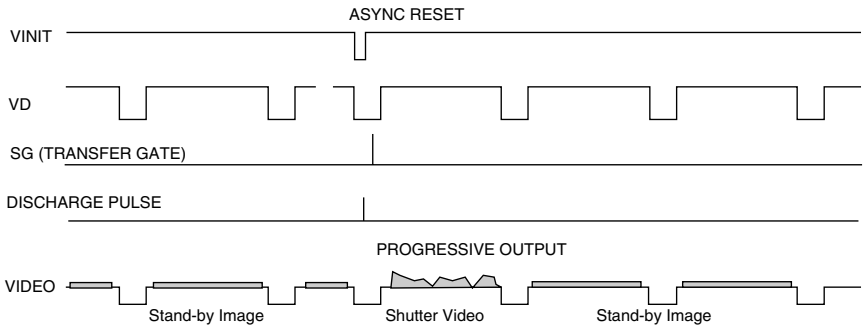
The TM-1020 series has a substrate drain-type shutter mechanism which provides a superb picture at various speeds without smearing. A built-in manual shutter speed control selects the electronic shutter rate of 1/60 (non-async mode only), 1/125, 1/250, 1/500, 1/1,000, 1/2,000, 1/4,000, 1/8,000, or 1/16,000 second.

With VINIT high (5V), the CCD keeps discharging. With a negative pulse to VINIT, the camera resets and purges the charge momentarily. Then it starts integrating for the period of shutter control set by either an external pulse width or internal shutter control. Progressive scanning permits a full 1000 lines of vertical resolution, as compared to a conventional CCD camera which captures only half the vertical lines per shutter.

3.5 Integration

The CCD imager of the TM-1020 series can be exposed for longer than the normal scan timing of 1/15 sec. This integration feature provides extra sensitivity for dark-environment applications. The progressive-scan imager permits a full frame of resolution in non-interlace format. Integration is achieved by controlling the #11 pin of the 12-pin connector to low (GND) or providing pulse-width control up to 1/15 frames. Please refer to Figure 2.2.2 on page 6 for pin-out information on the 12-pin connector.

3.6 Asynchronous Reset



The TM-1020 series's asynchronous reset is flexible and accepts external horizontal drive (HD) for phase locking. When the VINIT pulse is applied, it resets the camera's scanning and purging of the CCD. For asynchronous image capturing by frame grabbers, it outputs single FDV at async reset. For the TM-1020-15 and -15CL versions, there are three modes to control the asynchronous reset and shutter speed:

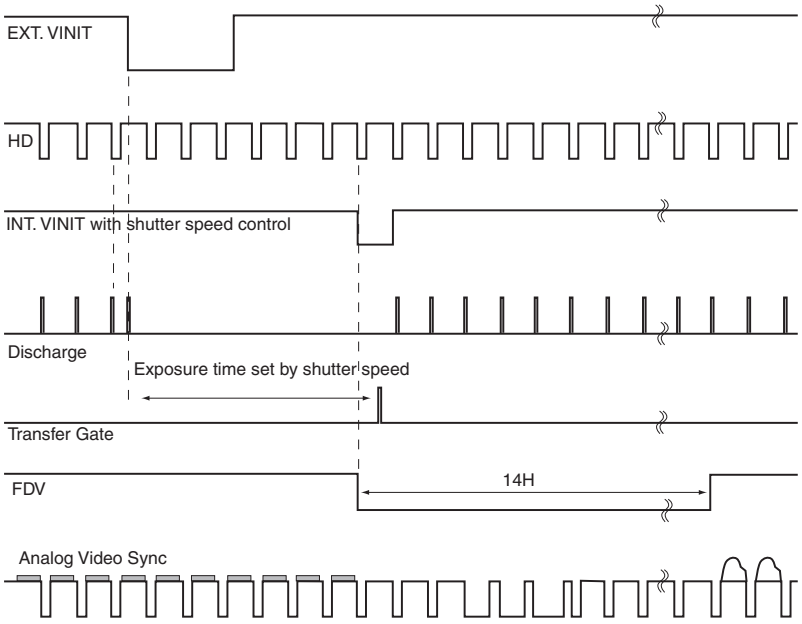
- Internal Shutter Speed with Fast Mode
- Internal Shutter Speed with Slow Mode
- External VINIT with Pulse Width

For the entire line of TM-1020 series cameras except the -15 and -15CL models, there are two modes to control the asynchronous reset and shutter speed:

- Internal Shutter Speed Control
- External VINIT with Pulse Width

3.6.1 Internal Shutter Speed Control (TM-1020 Series)

FIGURE 9. Internal Shutter Speed Control (TM-1020 Series)



The video signal starts with internal VINIT. The camera operates the reset and shutter in the same way as the external pulse width control mode. When the external VINIT pulse is applied, internal VINIT is latched to HD and the internal VINIT is delayed to set up the shutter speed period. The shutter speed is controlled by the dial switch from “1” to “8.” Video output timing starts right after the internal VINIT and single shots, FDV is output at the internal VINIT timing.

3.6.2 External VINIT With Pulse Width No-Delay Shutter and ROI (Read-out Inhibit) (TM-1020 Series)

For multiple-camera applications such as 2D or 3D measurement and multi-angle inspection, simultaneous image capturing at an exact shutter timing for all cameras is critical requirement. The TM-1020 series’s asynchronous pulse-width control mode provides no-delay shutter as standard. Regardless of the internal pulse timing, the camera discharges at the VINIT leading edge and trasfers charges at the trailing edge of the pulse. Even though each camera runs with slightly different H and data clock timing, the image capturing is exactly simultaneous.

FIGURE 10. No-Delay Shutter

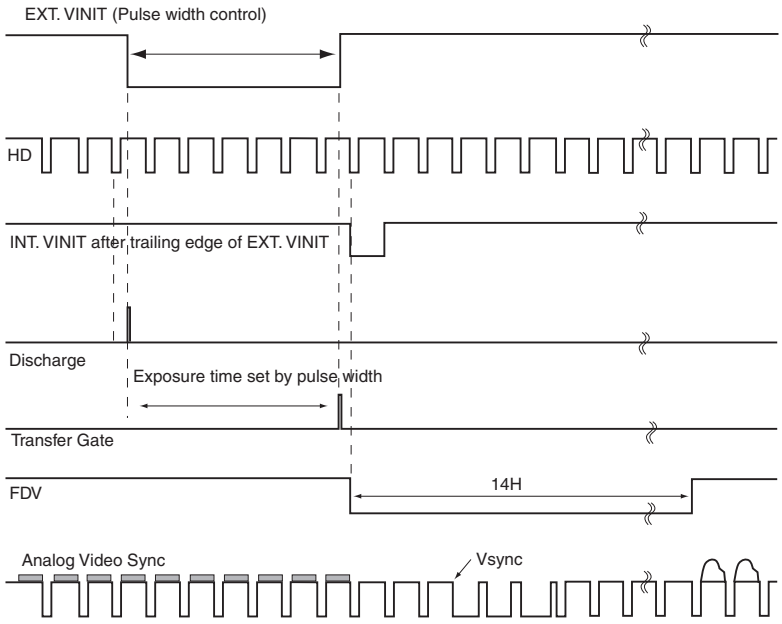
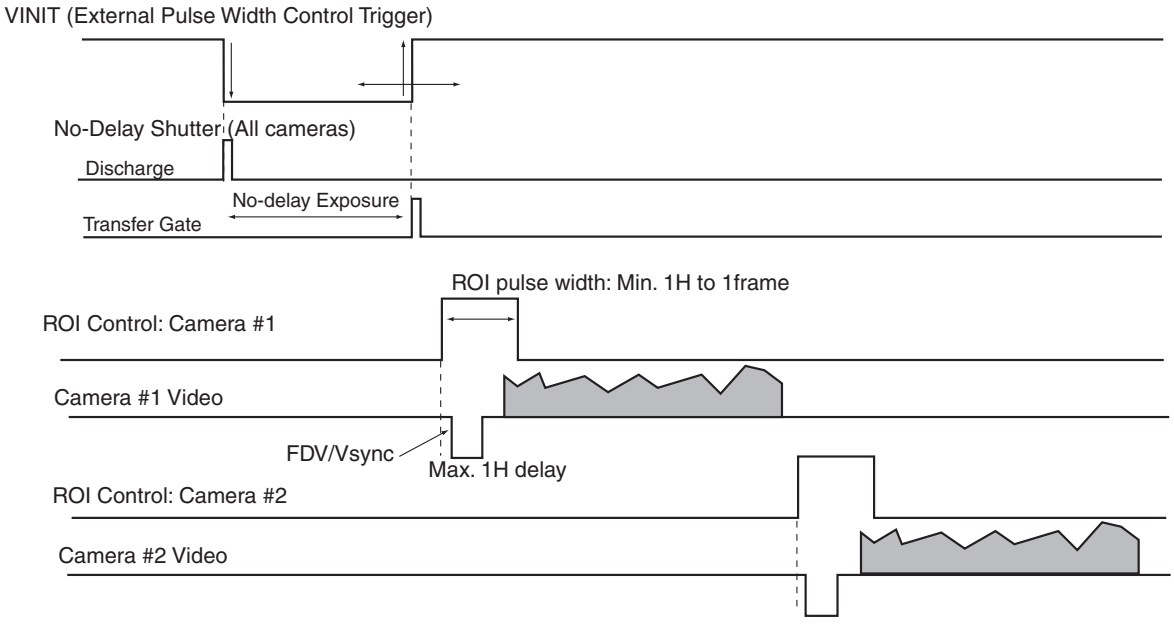


FIGURE 11. No-Delay Shutter and Read-Out Inhibit

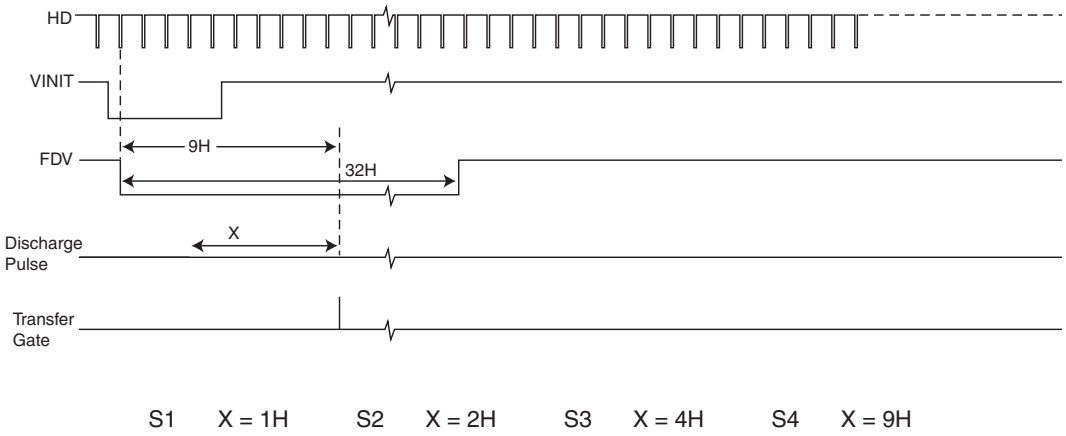


The TM-1020A series also has read-out-inhibit control (ROI) to control the vertical clock start (Async Shutter #9). When ROI is low, V-clock is stopped and the transferred charges remain in the vertical shift registers, which work like CCD memory. When the ROI is high, it clocks out the CCD data. This helps a single frame grabber process multiple images in pipeline processing (sequential process).

Note: When the ROI function is not used, make sure that the INTEG/ROI inputs (#11 of 12-pin connector, #6 of the 31-pin connector, and #10 and #23 of the Camera Link connector) are kept open or logic high during Async. pulse width control mode.

3.6.3 Internal Shutter Speed with Fast Mode (TM-1020-15 only)

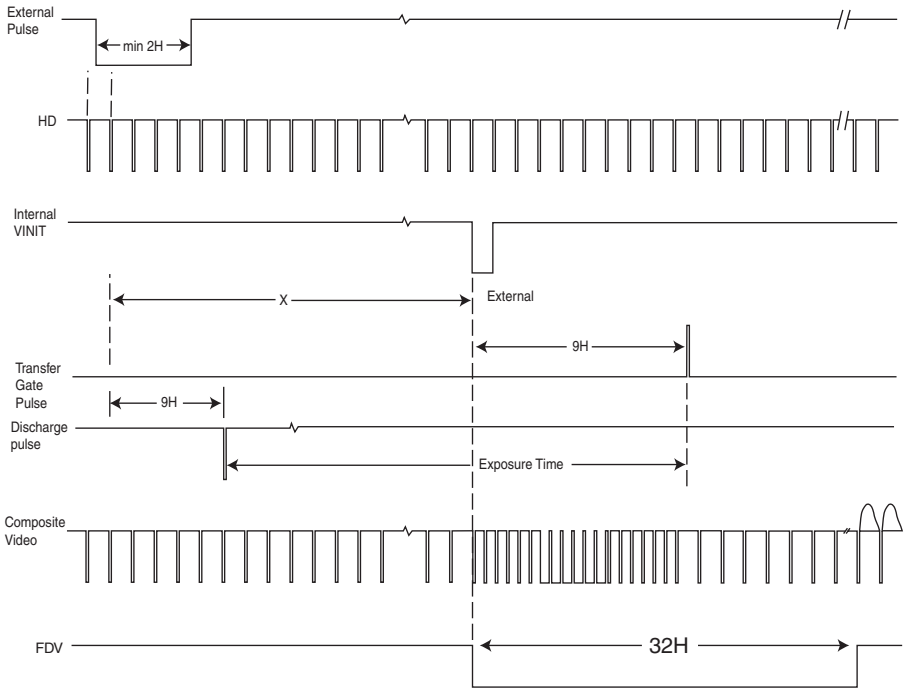
FIGURE 12. Internal Shutter Speed with Fast Mode (TM-1020-15 only)



The video signal has no delay from the reset timing. Shutter speed range is 1/2,400 to 1/31,000 sec. Select a dial switch setting from “1” to “4”. When the fast reset mode is selected, the camera resets with internal VINIT timing, which is latched to HD. Video output is also synchronized with internal VINIT timing without further delay. The shutter speed is controlled by the dial switch.

3.6.4 Internal Shutter Speed with Slow Mode (TM-1020-15 Only)

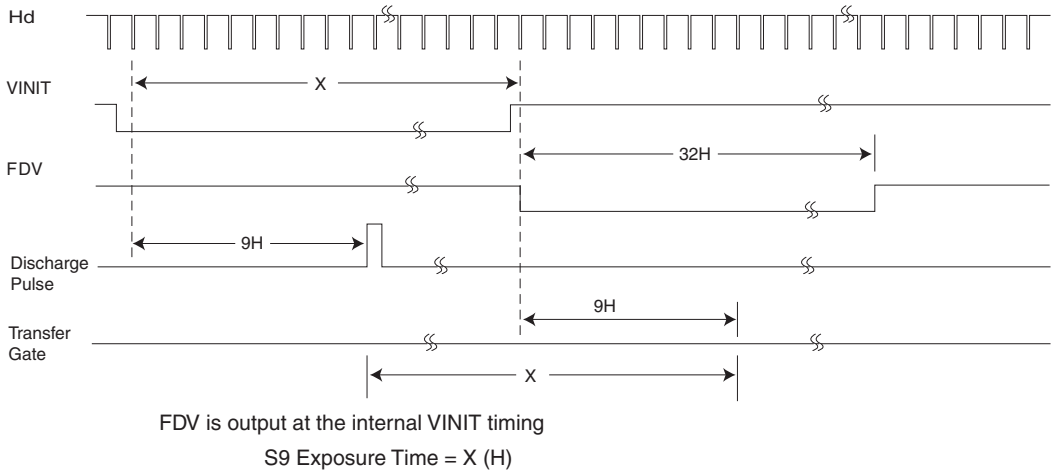
FIGURE 13. Internal Shutter Speed with Slow Mode (TM-1020-15 Only)



The speed control ranges from 1/120 to 1/950 sec. The video signal starts with internal VINIT. Select a dial switch setting from “1” to “4.” With the internal slow reset mode selected, the camera operates the reset and shutter in the same way as the external pulse width control mode. When the external VINIT pulse is applied, internal VINIT is latched to HD and the second internal VINIT signal is delayed to set up the shutter speed period. The shutter speed is controlled by the dial switch from “5” to “8.” Video output timing starts right after the internal VINIT. For the timing of the delayed internal reset, LPULSE output of the 51-pin connector can be used.

3.6.5 External VINIT with Pulse Width (TM-1020-15 Only)

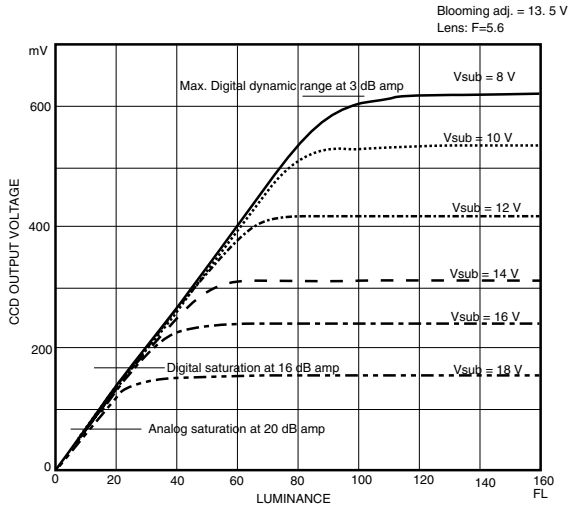
FIGURE 14. External VINIT with Pulse Width (TM-1020-15 Only)



The TM-1020 series can be reset with external reset pulse (VINIT). Set the dial switch to "9." Apply a pulse-width control VINIT signal generated from an external event trigger to the camera. The internal reset pulse will be latched to HD and at the 9th HD timing from the external pulse leading edge (negative going edge). The CCD discharge pulse will be generated to clear the images. The internal VINIT will be generated at the following edge (positive going edge) of the external pulse, resetting the internal timing including the video sync. The shutter speed is the same as the external pulse width, but the integration delays 9H from the leading edge. For the immediate reset option, please contact PULNiX.

For the progressive format, one frame of video output will start from the rising edge of the pulse width control. When VINIT is kept high (5V), subsequent frames will contain black or invalid video until the next falling edge of Vinit triggers another frame.

3.7 Dynamic Range Control



The typical interline transfer CCD has fixed noise levels based on dark current (thermal or KT noise), pattern noise, and the operating clock speed. In general, the level of the 20 MHz pixel clock CCD at room temperature is around 20 to 50 electrons. The maximum capacity of CCD charges is limited by the well capacity at saturation. The range is limited by the structure and the pixel size.

The TM-1020 series uses a 1" CCD with 9.0 µm x 9.0 µm pixel and two-phase vertical shift register structure. The well capacity is 50,000 electrons. The theoretical dynamic range is 50,000:30 = 1667:1 (64 dB).

A typical CCD camera does not use the full dynamic range due to the nominal gain and the output specification such as RS-170. The typical CCD camera's gain is set at 16 to 22 dB and the RS-170 video level is 714 mV. Using 20 dB gain for the calculation, CCD output is limited to 714/10 = 71.4 mV. Since the CCD's saturation voltage is 400 mV to 500 mV, it uses less than 1/5 of the full dynamic range.

Machine vision and outdoor applications, cannot afford to miss image information behind the saturation, which is why the dynamic range adaptation is critical.

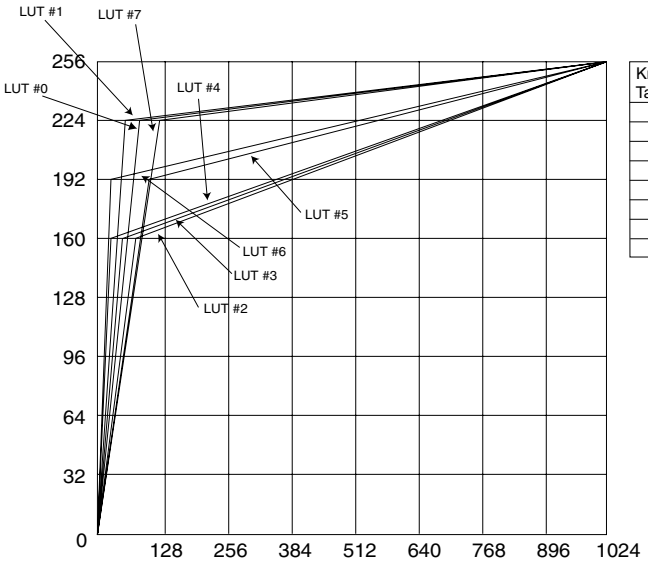
3.7.1 Programmable Look-Up Table (LUT) and Knee Control

The TM-1020 series has a built-in LUT (look-up table) for dynamic range control.

At a specific gain setting, the offset (minimum level.... dark point) and A/D reference top voltage (maximum level... saturation point) are set to 10-bit A/D input so that the full dynamic range of the CCD is utilized at 10-bit references as the input and the LUT output is converted into 8-bit to adjust the gamma correction.

The look-up table has two knee points (variable gamma selection) that allow the 10-bit input to be segmented into three regions. The look-up table selection can be made either by variable knee curve or by direct input.

FIGURE 15. Look-Up Table



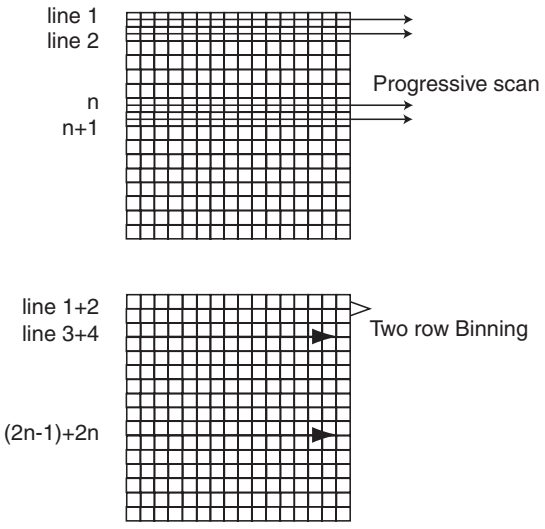
Knee Table	Left Knee (X1,	Y1)	Right Knee (X2,	Y2)
0	84	224	1024	256
1	56	224	1024	256
2	80	160	1024	256
3	60	160	1024	256
4	40	160	1024	256
5	96	192	1024	256
6	48	192	1024	256
7	112	224	1024	256

Note: The second knee point on the built-in LUT defaults to position (1024, 256). To reposition this point, click on it and drag it to a new location.

3.8 Scan Modes

The TM-1020 series supports the following scan modes:

FIGURE 16. Scan Modes



3.8.1 Full Progressive Scan

Normal scanning mode the TM-1020 series is for 1008 x 1018 pixels. The standard speed with single-channel output is 15 frame/sec at the pixel clock of 20 MHz. The progressive scan reads every line from top to bottom and, unique in an interlace-scan camera, all lines are obtained per image capturing with electronic shutter.

3.8.2 Two-Row Binning

This is a standard feature in the TM-1020 series. The camera scans two rows together and outputs 1008 (H) x 509 (V) pixels at 30 frames per second. Two-row binning is typically implemented to increase speed and to display real-time images on multi-sync monitors. When scan mode is changed from full progressive scan to two-row binning, then the camera settings will default to those in page 1 settings.

3.9 External Sync and Pixel Locking

The TM-1020 series accepts an external sync of standard HD and VD at TTL level for general locking to a system sync and clock. The external sync is not available in two-row binning and the frequency requirement is as follows:

15 Frame/Sec Models:

fHD = 15.734 KHz ±5%
fVD = 15.00 Hz ± 5%
(Internal Master clock = 40.00 MHz,
Pixel clock = 20.00 MHz)

30 Frame/Sec Models:

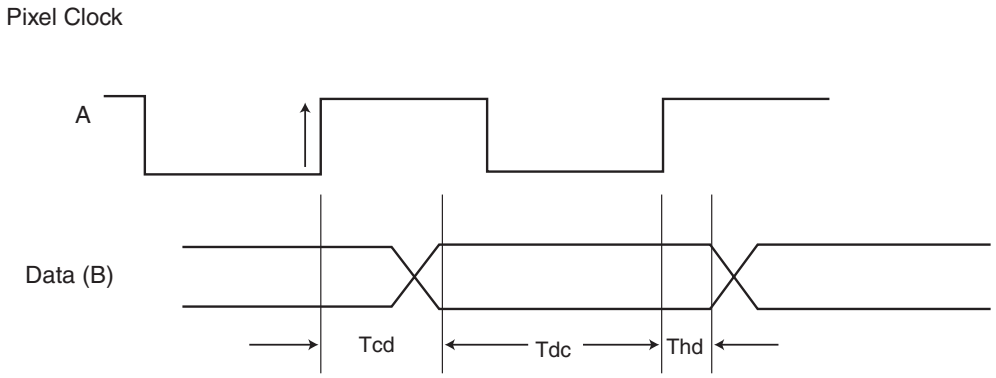
fHD = 31.47 KHz ±5%
fVD = 30.00 Hz ± 5%
(Internal Master clock = 80.00 MHz,
Pixel clock = 40.00 MHz)

3.10 Camera Timing Charts

Model: TM-1020-15 Operation Mode: 15 fps

Master Clock: 40.0 MHz, M= 25 nsec
Pixel Clock: 20.0 MHz, P= 50 nsec

1. Pixel Clock and Digital Data

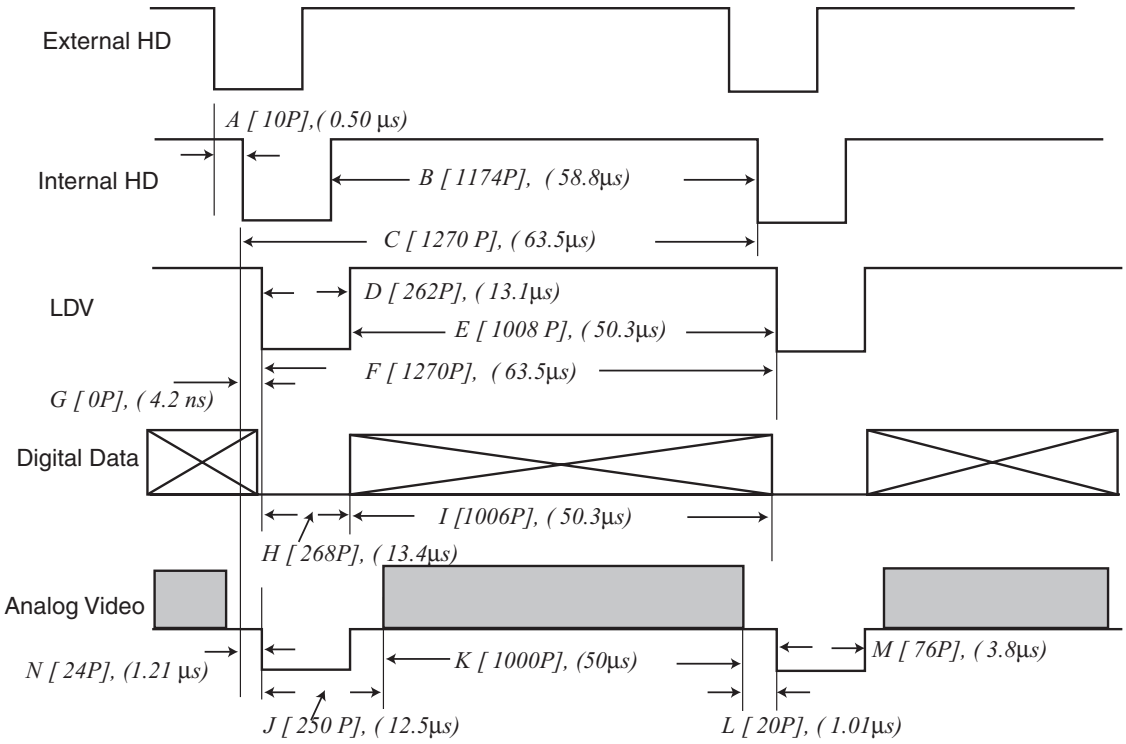


Tcd: Clock to Data Ready
Tdc: Data Ready to Next Clock
Thd: Data Hold Time

Tcd = 19.00 nsec, Tdc = 31.00 nsec, Thd = 11.00 nsec.

2. Horizontal Signals

fHD = [15.75 KHz]
tHD = [63.50 µsec]


External HD
A [10P],(0.50 µs)
Internal HD
B [1174P], (58.8µs)
C [1270 P], (63.5µs)
LDV
D [262P], (13.1µs)
E [1008 P], (50.3µs)
F [1270P], (63.5µs)
G [0P], (4.2 ns)
Digital Data
I [1006P], (50.3µs)
H [268P], (13.4µs)
Analog Video
N [24P], (1.21 µs)
K [1000P], (50µs)
M [76P], (3.8µs)
J [250 P], (12.5µs)
L [20P], (1.01µs)

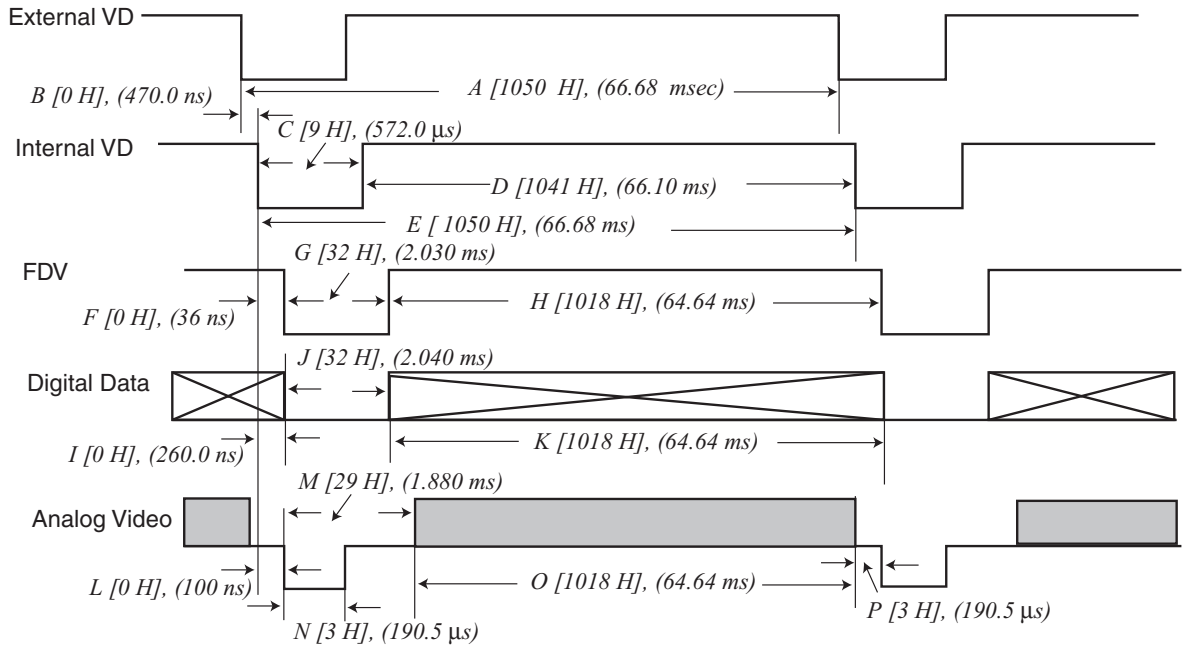
Model: TM-1020

Operation Mode: 15 Frames/Second

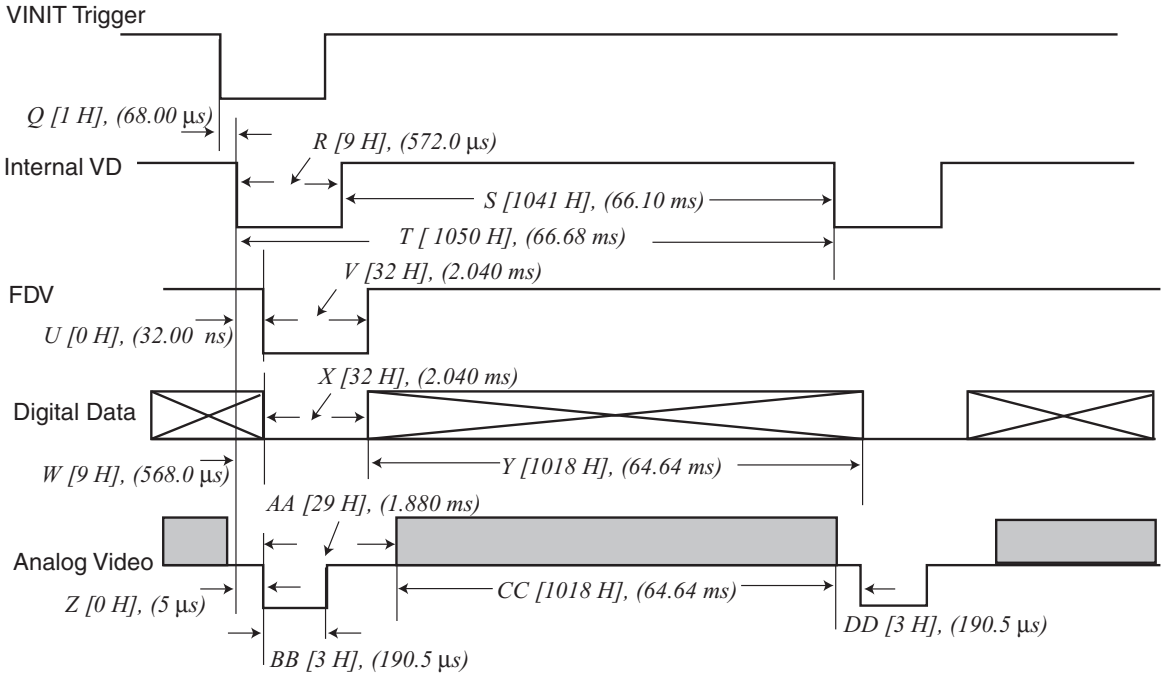
Master Clock: 40 MHz, M= 25 nsec
Pixel Clock: 20 MHz, P = 50 nsec

Horizontal Frequency: 15.748 KHz
1H = 63.50 µsec

3. External Reset Timing


External VD
B [0 H], (470.0 ns)
A [1050 H], (66.68 msec)
C [9 H], (572.0 µs)
Internal VD
D [1041 H], (66.10 ms)
E [1050 H], (66.68 ms)
G [32 H], (2.030 ms)
FDV
F [0 H], (36 ns)
H [1018 H], (64.64 ms)
J [32 H], (2.040 ms)
Digital Data
I [0 H], (260.0 ns)
K [1018 H], (64.64 ms)
M [29 H], (1.880 ms)
Analog Video
L [0 H], (100 ns)
O [1018 H], (64.64 ms)
P [3 H], (190.5 µs)
N [3 H], (190.5 µs)

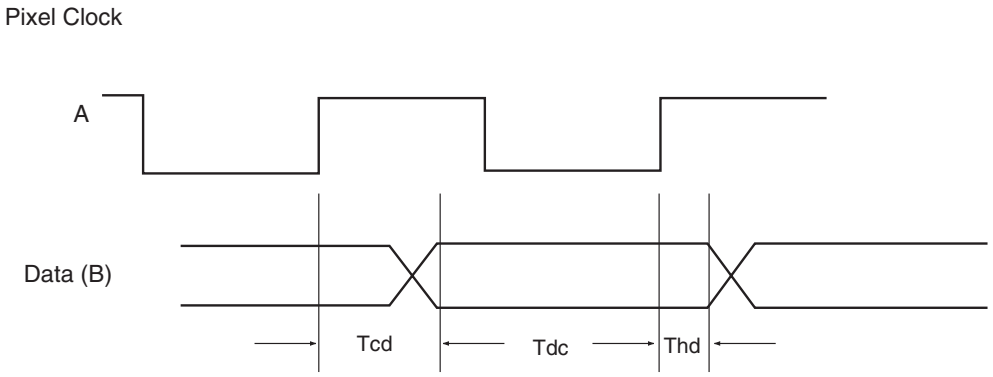
4. Async Reset Timing


VINIT Trigger
Q [1 H], (68.00 µs)
R [9 H], (572.0 µs)
Internal VD
S [1041 H], (66.10 ms)
T [1050 H], (66.68 ms)
V [32 H], (2.040 ms)
FDV
U [0 H], (32.00 ns)
X [32 H], (2.040 ms)
Digital Data
W [9 H], (568.0 µs)
Y [1018 H], (64.64 ms)
AA [29 H], (1.880 ms)
Analog Video
Z [0 H], (5 µs)
CC [1018 H], (64.64 ms)
DD [3 H], (190.5 µs)
BB [3 H], (190.5 µs)

Model: TM-1020-30 Operation Mode: 30 fps

Master Clock: 80.0 MHz, M= 12.5 nsec
Pixel Clock: 40.0 MHz, P= 25 nsec

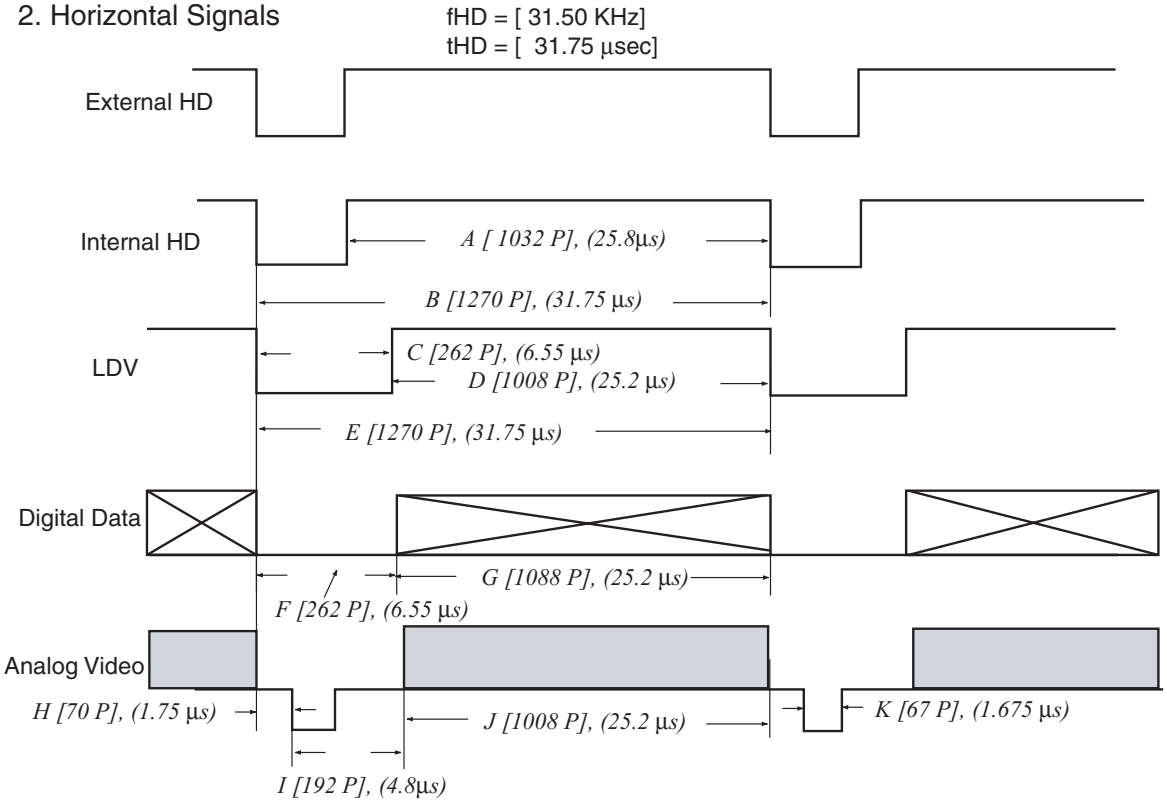
1. Pixel Clock and Digital Data



Tcd: Clock to Data Ready
Tdc: Data Ready to Next Clock
Thd: Data Hold Time

Tcd = 9.0 nsec, Tdc = 16.0 nsec, Thd = 6.00 nsec.

2. Horizontal Signals


fHD = [31.50 KHz]
tHD = [31.75 µsec]
External HD
Internal HD
A [1032 P], (25.8µs)
B [1270 P], (31.75 µs)
LDV
C [262 P], (6.55 µs)
D [1008 P], (25.2 µs)
E [1270 P], (31.75 µs)
Digital Data
G [1088 P], (25.2 µs)
F [262 P], (6.55 µs)
Analog Video
H [70 P], (1.75 µs)
J [1008 P], (25.2 µs)
K [67 P], (1.675 µs)
I [192 P], (4.8µs)

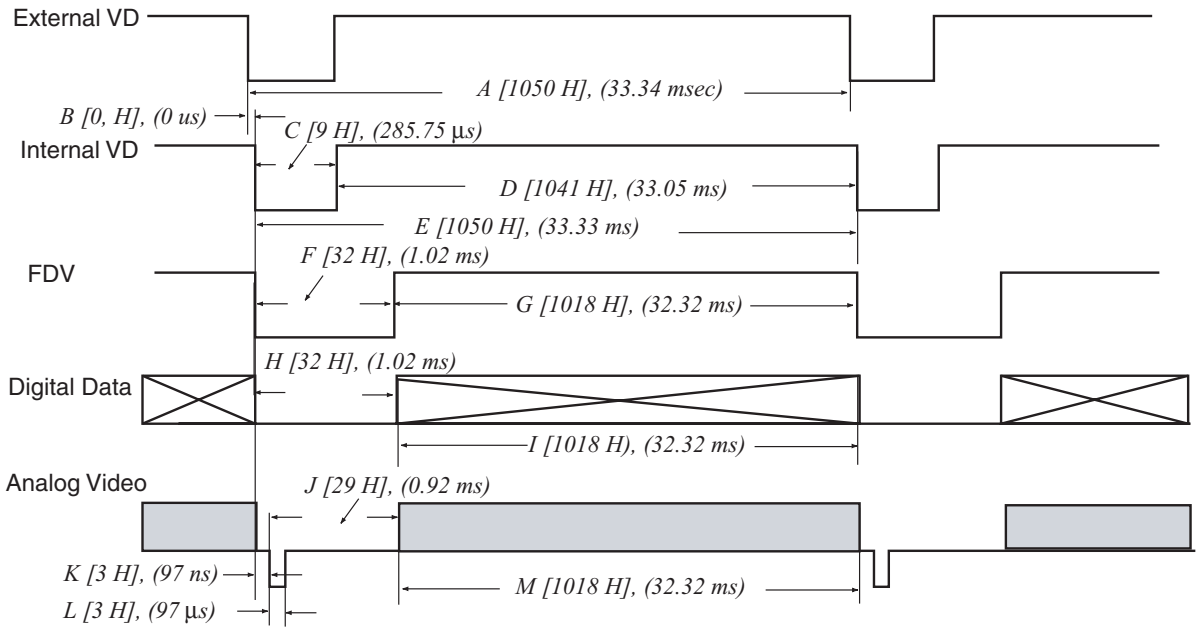
Model: TM-1020-30

Operation Mode: 30 Frames/Second

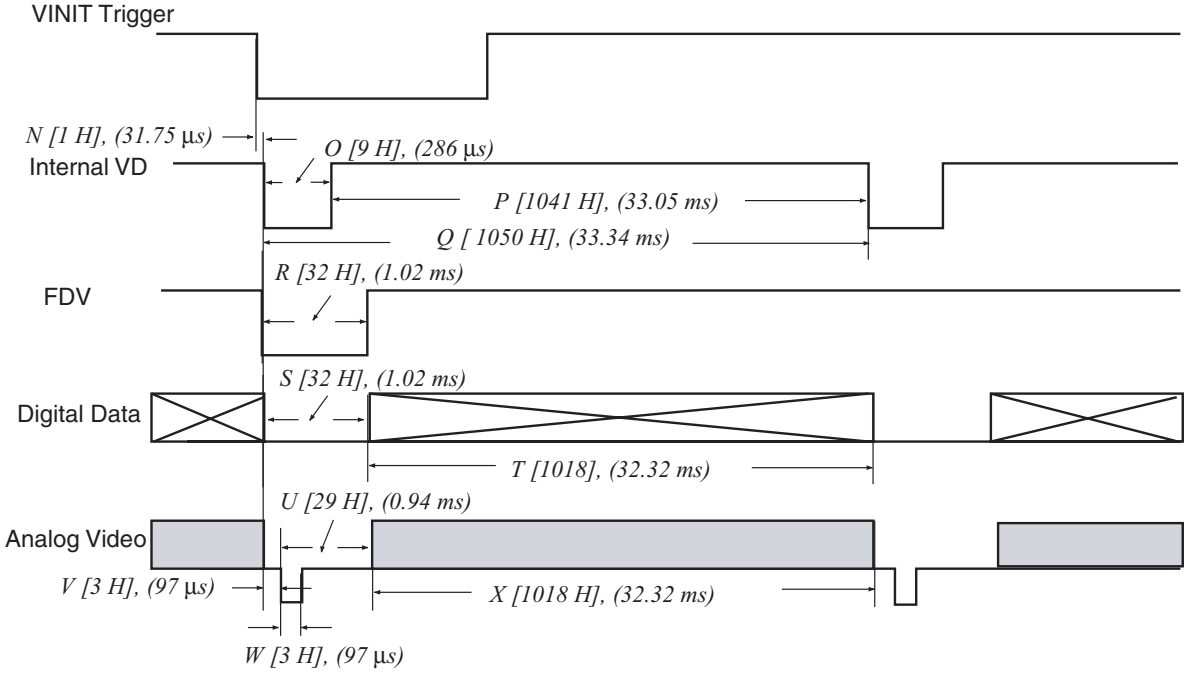
Master Clock: 80 MHz, M= 12.5 nsec
Pixel Clock: 40 MHz, P = 25 nsec

Horizontal Frequency: 31.50 KHz
1H = 31.75 sec

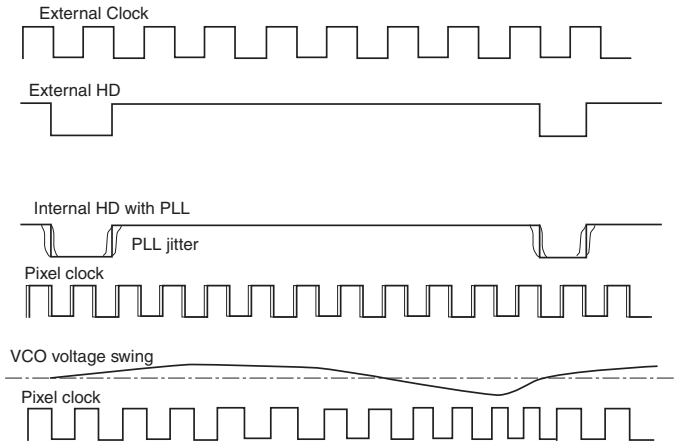
3. External Reset Timing


External VD
A [1050 H], (33.34 msec)
B [0, H], (0 us)
C [9 H], (285.75 µs)
Internal VD
D [1041 H], (33.05 ms)
E [1050 H], (33.33 ms)
F [32 H], (1.02 ms)
FDV
G [1018 H], (32.32 ms)
H [32 H], (1.02 ms)
Digital Data
I [1018 H), (32.32 ms)
Analog Video
J [29 H], (0.92 ms)
K [3 H], (97 ns)
L [3 H], (97 µs)
M [1018 H], (32.32 ms)

4. Async Shutter 0 Reset Timing


VINIT Trigger
N [1 H], (31.75 µs)
O [9 H], (286 µs)
Internal VD
P [1041 H], (33.05 ms)
Q [1050 H], (33.34 ms)
R [32 H], (1.02 ms)
FDV
S [32 H], (1.02 ms)
Digital Data
T [1018], (32.32 ms)
U [29 H], (0.94 ms)
Analog Video
V [3 H], (97 µs)
X [1018 H], (32.32 ms)
W [3 H], (97 µs)

3.10.1 Pixel Clock Locking (optional)[1]



For multiple-camera applications such as 2D or 3D measurement, multiple-camera inspection, a parallel digital data input capability is important. The high resolution and precision measurement requires that camera data be consistent with each other and free from PLL jitter. This is especially important for digital output multiplexing. The TM-1020 series has an optional capability for pixel clock locking. It takes RS-422 (differential) external clock and H and V reset sync (TTL or RS-422). By doing this, each camera's digital data is in-phase with the pixel clock (data clock) for multiplexing or parallel input to a frame grabber.

3.11 Serial Communication Kit

- **LVDS/RS-422 Version** The LVDS/RS-422 version's functions can be controlled by a PC via RS-232C communication using the CS-232E serial communication kit. This kit consists of the RS-232B-12 cable, software disk, and quick-start card. The software disk contains setup files for the graphical user interface (GUI) program. Please refer to the AccuPiXEL Series Camera-Control Software manual for information on the GUI.
- **Camera Link** The Camera Link version's control software is also included in the AccuPiXEL Camera Control software.

1. Pixel clock locking option not available at time of publishing. Please check with PULNiX for option availability.

4 LVDS-Version Camera RS-232 Commands

The LVDS-version camera can be controlled via RS-232 commands. The Start character is always ":" and the end character is always "CR" (return). For example, to set Asynchronous Pulse Width Mode, send the command :SA9"CR" to the camera. The following table contains RS-232 commands that can be used to control the camera.

TABLE 7. RS-232 Command List

	First Character	Second Character	Third Character	Response	Functions
1	"S" (shutter)	"M" (Manual)	"0" - "9" Mode	ACK	Manual Shutter Mode
		"A" (ASYNC)	"0" - "8" Mode	ACK	Async Shutter Mode
			"9" (Pulse Width Mode)	ACK	Async Pulse Width Mode
2	"G" (Gain)	"M"	"00" - "FF"	ACK	Gain Control
3	"V" (A/D Vref)	"T" (Top)	"00" - "FF"	ACK	Vtop reference setting
		"B" (Bottom)	"00" - "FF"	ACK	Vbtm reference setting
4	"W" (Write)	"P" (Page)	"0" - "6"	ACK	Write current setting to Page EEPROM
		"U" (User)	"A" - "D"	ACK	Write current setting to User EEPROM
		"S" (System)	"A" - "D"	ACK	Write current setting to System EEPROM
5	"L"	"P" (Page)	"0" - "6"	ACK	Restore setting from Page EEPROM
		"U" (User)	"A" - "D"	ACK	Restore setting from User EEPROM
		"S" (System)	"A" - "D"	ACK	Restore setting from System EEPROM
		"N" (kNee)	"0" - "9"	ACK	Load Preset Knee Table
6	"R" (Report)	"P" (Page)	"0" - "6"	ACK	ACK + "P" + ("9" - "F") + 16 bytes
		"U" (User)	"A" - "D"	ACK	ACK + "U" + ("A" - "D") + 6 bytes
		"S" (System)	"A" - "D"	ACK	ACK + "S" + ("A" - "D") + (6 bytes)
		"R" (Current)		ACK	ACK + "RR" + 16 bytes
		"X" (Execute)		ACK	Set Camera with loaded data
		"D" (Date)		info	Report CPU program version

	First Character	Second Character	Third Character	Response	Functions
7	"T" (Table)	"N" (kNee)	X1 + Y1 + X2 + Y2	ACK	(X1, Y1) coordinate for knee 1
			X1, Y1, X2, Y2: "00 - FF"		(X2, Y2) coordinate for knee 2
		"M" (Gamma)		ACK	
		"L" (Linear)		ACK	
		"C" (Switch A, B Table)	"0" or "1"	ACK	
8	"N"	"0" (Normal)		ACK	Normal Scan Formal
		"1" (Binning)		ACK	Double Speed Binning

Note: One byte of data consists of two ASCII codes. For example, 0x3A is "3" (0x33). "A" (0x41) x <ACK> is 0x06. <NAK> is 0x15.

This command's basic protocol is the same for Camera Link model cameras.

5 Troubleshooting

5.1 Problems and Solutions

Following are troubleshooting tips for common problems. In general, problems can easily be solved by following these instructions. If the following remedies fail to offer a solution to your problems, please contact a PULNiX representative.

5.1.1 Symptom: No Video

Remedies: Check that the following are properly connected and operational.

- Power supplies
- Power cables
- Main power source
- Shutter control
- Async mode
- Lens
- Digital output cable
- Analog video cable

5.1.2 Symptom: Dark Video

Remedies: Check that the following are properly connected and operational.

- Shutter selection
- Iris opening on the lens

5.1.3 Symptom: Non-synchronized Video

Remedies: Check that the following are properly connected and operational.

- Proper mode output
- Frame grabber software camera selection

5.2 Information and Support Resources

For further information and support:

Phone:	(408) 747-0300
	(800) 445-5444
	(800) 3-PULNIX (24-hour message access)
Fax:	(408) 747-0660
E-mail:	imaging@pulnix.com
Mail:	PULNiX America Inc.
	Sales Department
	1330 Orleans Drive
	Sunnyvale, CA 94089
	ATTN: Video Applications
Web Site:	www.pulnix.com

6 Appendix

6.1 Specifications

TABLE 8. TM-1020 Series Camera Specifications Table

Feature	TM-1020-15 TM-1020-15CL TM-1020A-15	TM-1020-30 TM-1020-30CL
Imager	1” (9.1mm x 9.2mm) progressive scan interline transfer CCD	
Pixels	1024 (H) x 1024 (V), 1008 x 1018 active	
Cell size	9.0µm x 9.0µm	
Scanning	1050 lines at 15Hz; 1024 x 512 lines at 30Hz (two-row binning)	1050 lines at 30Hz Partial scan: 500L at 58Hz : 250L at 102Hz
Sync	Internal/external auto switch HD/VD, 4.0 Vp-p impedance 4.7KΩ VD=15Hz±5%, non-interlace HD=15.734kHz±5%	Internal/external auto switch HD/VD, 4.0 Vp-p impedance 4.7KΩ VD=30Hz±5%, non-interlace HD=31.47kHz±5%
Data clock output	20.000 MHz	40.000 MHz
Resolution	Digital: 1008 (H) x 1018 (V), (Analog: over 700 TV lines (H) x 800 TV lines (V))	
S/N ratio	50dB min. (AGC: off)	
Min. illumination	1.0 lux with factory defaults: f=1.4 without IR cut filter (no shutter) Sensitivity: 12µV/ e-	
Video output	Analog: 1.0 Vp-p composite video, 75Ω Digital output: 8-bit RS-644 (TM-1020-15: 12S-RS-422) Camera Link (CL models only)	Analog: 1.0 Vp-p composite video, 75Ω Digital output: 8-bit RS-644 Camera Link (CL model only)
AGC	Not available	
Gamma	Programmable LUT (1.0 std.)	
Lens mount	C-mount (use 1” format lenses)	
Power requirement	12V DC, 500mA (current measured at 25°)	
Operating temp.	-10°C to 45°C*	
Random vibration	7 Grms (10Hz to 2000Hz)	
Shock	70G	
Size (W x H x L)	44mm x 44mm 64mm (1.73” x 1.73” x 2.50”)	
Weight	Std. version:133 grams, 4.7 oz (without tripod) CL version: 137 grams, 4.8 oz (without tripod) tripod weight: 13.8 grams 0.5 oz	
Power cable	12P-02S (optional)	
Power supply	PD-12UUP (includes power connector)	

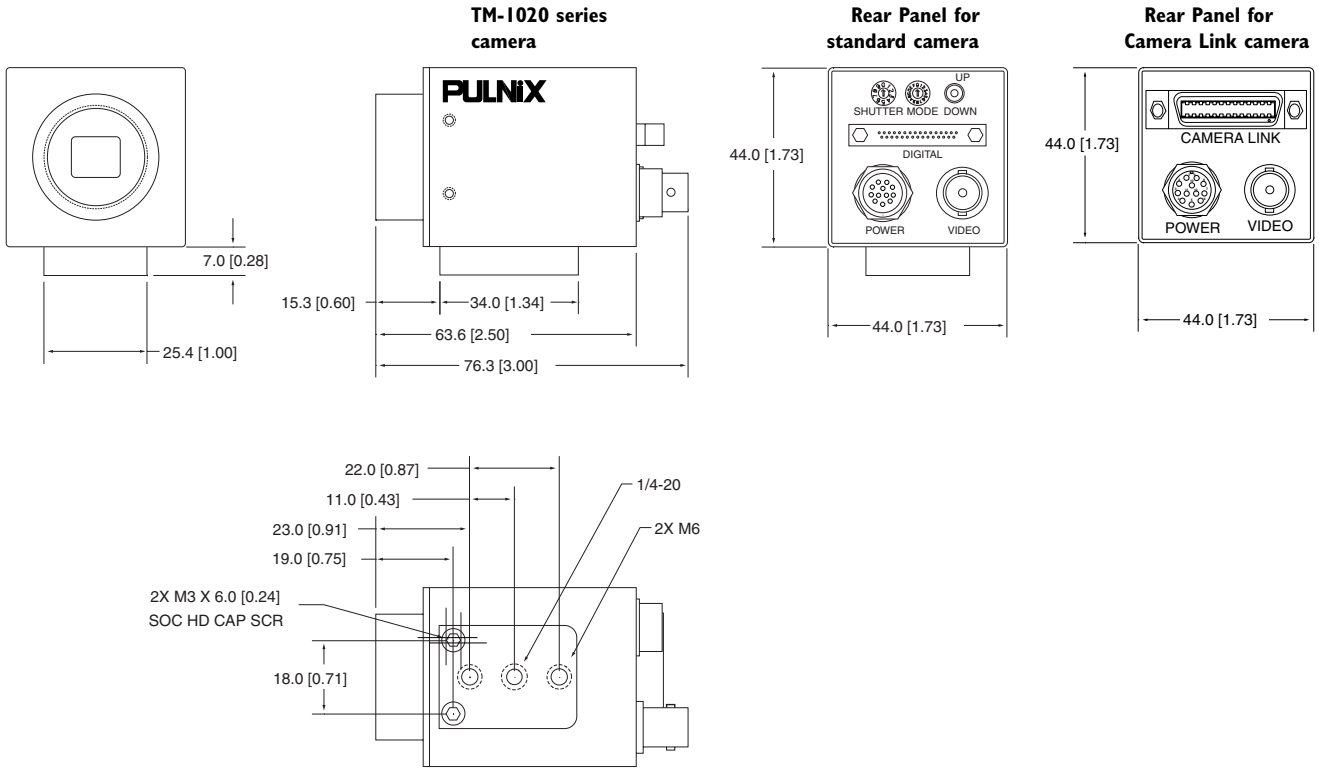
Feature	TM-1020-15 TM-1020-15CL TM-1020A-15	TM-1020-30 TM-1020-30CL
Functional options	Adjustable back-focus front end, pixel clock locking†	
I/O	26CL-02-26 digital output cable (CL models)	

*. Refer to Section 2.2.2 on page 6 for information on camera heat dissipation. Image quality will degrade with increasing temperature.

†. This option not available at time of publishing. Please check with PULNiX for current availability.

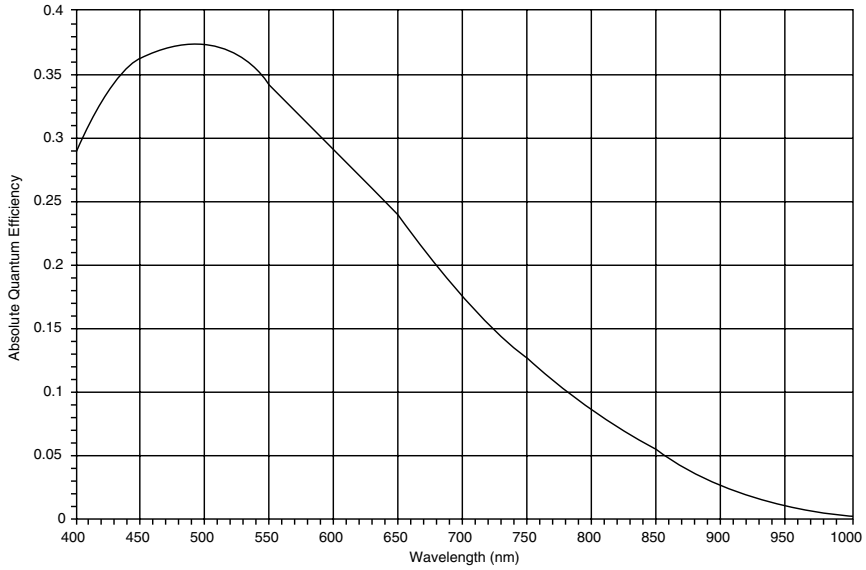
6.1.1 TM-1020 Series Physical Dimensions

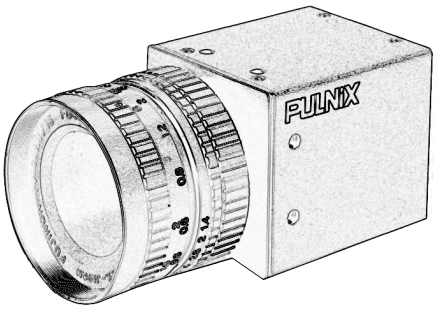
FIGURE 17. Physical Dimensions



6.1.2 Spectral Response

FIGURE 18. Spectral Response





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69-0076
Rev. B

AccuPiXEL Series Camera-Control Software

Installation and Operation Manual

69-0109
Rev. A

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All of our solid-state cameras have a full three-year warranty. If any such product proves defective during this warranty period, PULNiX America, Inc. will repair the defective product without charge for parts and labor or will provide a replacement in exchange for the defective product. This warranty shall not apply to any damage, defect or failure caused by improper use or inadequate maintenance and use.

WARNING

Changes or modifications to this unit not expressly approved by the party responsible for FCC compliance could void the user's authority to operate the equipment.

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FILE #A3942

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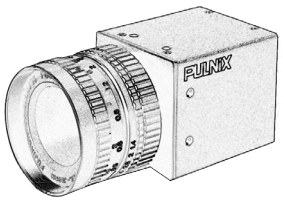
AccuPiXEL Series Camera-Control Software

PRELIMINARY Operation Manual



TM-1020-15, TM-1020-25, TM-1020-30, and CL versions
TM-1320-15, TM-1320-24, TM-1320-12, and CL versions
TM-2016-8, TM-2016-15, and CL versions
TM-6760 and TM-6760CL
TM-2020-8, TM-2020-15, and CL versions

1 Introduction

The AccuPiXEL series cameras are high resolution, progressive scan cameras with PULNiX-proprietary LUT control and other excellent features. The camera control software was developed to function as standard software for the entire AccuPiXEL series. This software can open either the RS-232 serial port (COM) or Camera Link. Camera Link users must physically install the Camera Link frame grabber board into the PC. They must also install the Camera Link API (clserXXX.dll) software. These cameras are specially designed to capture images in progressive scan (non-interlace) format, producing a full frame of electronic shutter images, as well as normal images.

1.1 Software Installation

Following are instructions to install the AccuPiXEL series camera-control software on a PC.

1.1.1 Before Installing the AccuPiXEL Series Camera-Control Software

Before installing the AccuPiXEL series Camera-Control Software, please note the following.

- The AccuPiXEL series camera-control software requires Microsoft Windows 95, 98, NT 4.0., or Windows 2000.
- We recommend that you use small fonts for the Display Properties dialog box in the control panel.
- The AccuPiXEL series camera-control software requires one free communication port that is not in conflict with other peripherals such as the mouse or modem.
- Installation of the AccuPiXEL series camera-control software requires 2.0 MB of free space in your PC hard disk.

1.1.2 Installing the Software

To install the AccuPiXEL series camera-control software, follow the steps below.

1. Insert the installation diskette into the floppy drive of your PC and run "Setup.exe."
2. The installer will direct you to install the application code.
3. Follow the installer instructions.

***Note**: You can change the installation directory if you want.*

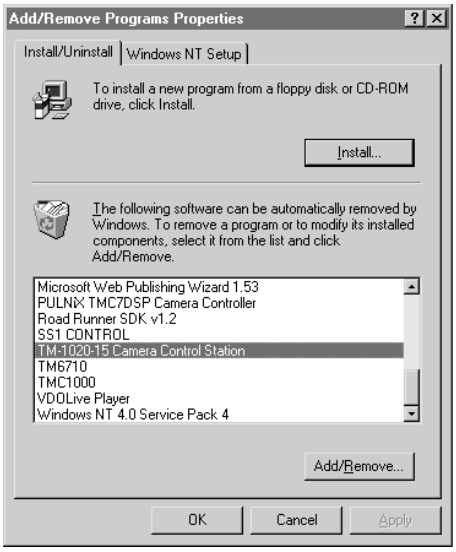
1.1.3 Installing the Camera Link API DLL (clserXXX.dll)

To install the Camera Link control software with frame grabber software, please consult the frame grabber company or PULNiX.

1.1.4 Uninstalling the Software

You can uninstall the AccuPiXEL series camera-control software from the control panel. To uninstall, follow the steps below.

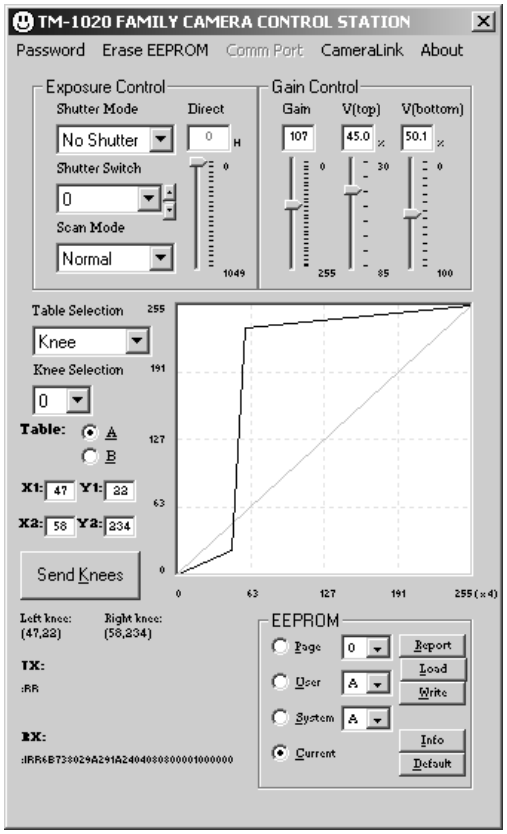
1. Open "Add/Remove Programs" in the control panel.
2. Select "TM-1020 Camera Control Station" from the lists of the installed software.
3. Click the "Add/Remove" button, then click "Yes" to confirm.


Add/Remove Programs Properties
Install/Uninstall
Windows NT Setup
To install a new program from a floppy disk or CD-ROM drive, click Install.
Install...
The following software can be automatically removed by Windows. To remove a program or to modify its installed components, select it from the list and click Add/Remove.
Microsoft Web Publishing Wizard 1.53
PULNiX TMC7DSP Camera Controller
Road Runner SDK v1.2
SS1 CONTROL
TM-1020-15 Camera Control Station
TM6710
TMC1000
VDOLive Player
Windows NT 4.0 Service Pack 4
Add/Remove...
OK
Cancel
Apply

2 Graphical User Interface

2.1 GUI Features

The following is a list of camera functions that can be controlled by PC serial commands. The AccuPiXEL series Camera Link cameras use differential serial communication through the Camera Link connector on the rear panel of the camera.



- Shutter Mode and Speed
- Scan Mode (Normal, Binning)
- Gain
- LUT (Look-Up Table)
- Double Knee Control
- Write / Read settings into / from the EEPROM

2.2 Open the Link to the Camera

For the RS-232 serial port, refer to “Open RS-232 Port”, below. For Camera Link, refer to “Open Camera Link” below.

2.2.1 Open RS-232 Port

From the main menu tab, select “Comm Port” and click “Open.” Select the port number, and set 9600 bps, no parity, 8 data bits, 1 stop bit, and click “Done.” Click on the “Report” button and the software updates the current settings onto the main control panel.

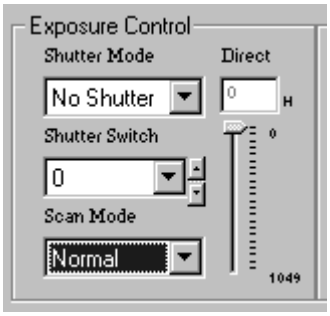
2.2.2 Open Camera Link

Select frame grabber board index. This index is for users who install multiple Camera Link frame grabbers. For a single board user, the index is selected as zero as default. Once the board index is set, open Camera Link. Choose the appropriate Camera Link API dll (typically named “clserXXX.dll”) which is provided by the frame grabber manufacturer. If the board is not installed or the wrong API dll is selected, an error message appears. If this happens, please contact PULNiX for further assistance. Click the “Report” button to reflect the current settings onto the main control panel.

2.3 Operating The Control Software

2.3.1 Exposure Control

In Exposure Control, you can specify the shutter mode and scan mode.



2.3.1 (a) Shutter Mode

In this list box you can select Manual or Asynchronous or Direct shutter or no shutter mode.

2.3.1 (b) Shutter Time

The Shutter Time list box allows you to select the specific shutter speed.

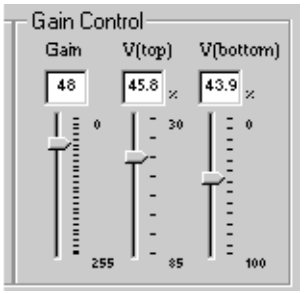
2.3.1 (c) Scan Mode

The AccuPiXEL series cameras have several selectable scan modes. The Scan Mode list box allows you to select scan mode (Normal, Binning).

2.3.2 Gain Control

2.3.2 (a) Gain

The Gain Control box allows you to change the Gain value from 0 to 255 (integer). To change the value, move the slider, or enter the value directly into the text box.



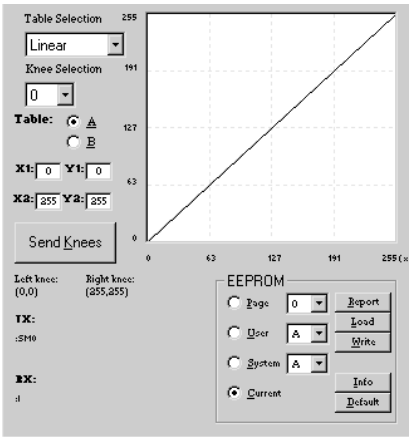
2.3.2 (b) V-Top

The V(top) box allows you to change the V(top) value of the A/D converter from 30% to 85% (integer). To change the value, move the slider or enter the value directly into the text box.

2.3.2 (c) V-Bottom

The V(bottom) box allows you to change the V(bottom) value of the A/D converter from 0 to 100% (integer). To change the value, move the slider or enter the value directly into the text box.

2.3.3 Knee Control



The Knee Control box allows you to set your own knee value to each LUT. For more detail regarding knee control, please refer to the appropriate hardware operation manual or datasheet.

2.3.3 (a) LUT (Look-Up Table) Selection

The LUT Selection box allows you to select the linear, knee, or gamma 0.45 output.

2.3.3 (b) Knee Selection

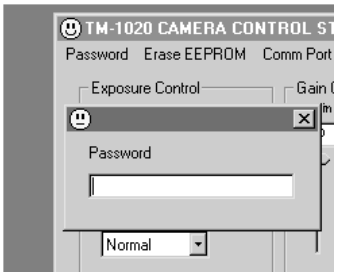
The Knee Selection box allows you to select the preset knee control LUT. The AccuPiXEL series cameras have 8 preset knee control LUTs.

2.3.3 (c) Knee Control

The Knee Control graphical control allows you to change two knee point values visually by clicking and dragging the "knee line." You may enter X_1, Y_1, X_2, Y_2 values directly to adjust the knee curve. When you have chosen the value you want and are ready to set this value to the camera, click the "Send Knees" button.

2.3.4 "Password" Menu

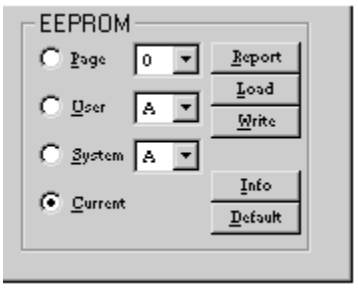
2.3.4 (a) Password



Please contact PULNiX for password access. The password allows access to the EEPROM to rewrite or erase factory settings.

2.3.5 "Erase EEPROM" Menu

2.3.5 (a) Load Setting From the EEPROM



The EEPROM section consists of three memory locations that allow you to Load (open), Write (save) and Report the current configuration.

"Page Memory" has seven pages available to write current configurations. Page "0" is the factory default configuration and cannot be edited without a password. Page memory "1" is power up default. This page will allow you to save your default configuration to load at power up. Page memory will allow you to save the current Exposure Control, Knee, Gain, Vtop, and Vbtm settings.

"User Memory" will allow you to load, write, and report the current configuration for Gain, Vtop, and Vbtm only.

"System Memory" is the same as "User Memory" except that it requires a password for access. "Current Memory" is the camera's current configuration. Select "Current" and click the "Report" button to display the cameras settings.

The "Load" option in the menu bar allows you to restore the Gain Table setting from EEPROM. Click on "Load" and select "From Gain Table" in the menu to restore the setting from four user memory pages and four preset setting memory pages.

3 AccuPiXEL Series Camera Serial Commands

The AccuPiXEL series cameras can be controlled by serial command either via RS-232 or Camera Link. The Start character is always ":" and the End character is always <CR> (return). For example, to set Asynchronous Pulse Width Mode, send the command :SA9<CR> to the camera. The following table contains serial commands that can be used to control the camera.

TABLE 1. Serial Command List

	First Character	Second Character	Third Character	Response	Functions
1	"S" (Shutter)	"M" (Manual)	"0" - "9" Mode	ACK	Manual Shutter Mode
		"A" (ASYNC)	"0" - "8" Mode	ACK	Async Shutter Mode
			"9" (Pulse Width Mode)	ACK	Async Pulse Width Mode
		"X"	"000" - "419"	ACK	Direct Shutter Mode
2	"G" (Gain)	"M"	"00" - "FF"	ACK	Gain Control
3	"V" (A/D Vref)	"T" (Top)	"00" - "FF"	ACK	Vtop reference setting
		"B" (Bottom)	"00" - "FF"	ACK	Vbtm reference setting
4	"W" (Write)	"P" (Page)	"0" - "6"	ACK	Write current setting to Page EEPROM
		"U" (User)	"A" - "D"	ACK	Write current setting to User EEPROM
		"S" (System)	"A" - "D"	ACK	Write current setting to System EEPROM
5	"L"	"P" (Page)	"0" - "6"	ACK	Restore setting from Page EEPROM
		"U" (User)	"A" - "D"	ACK	Restore setting from User EEPROM
		"S" (System)	"A" - "D"	ACK	Restore setting from System EEPROM
		"N" (kNee)	"0" - "9"	ACK	Load Preset Knee Table
6	"R" (Report)	"P" (Page)	"0" - "6"	ACK	ACK + "P" + ("9" - "F") + 16 bytes
		"U" (User)	"A" - "D"	ACK	ACK + "U" + ("A" - "D") + 6 bytes
		"S" (System)	"A" - "D"	ACK	ACK + "S" + ("A" - "D") + (6 bytes)
		"R" (Current)		ACK	ACK + "RR" + 16 bytes
		"X" (Execute)		ACK	Set Camera with loaded data
		"D" (Date)		info	Report CPU program version

TABLE 1. Serial Command List (Continued)

	First Character	Second Character	Third Character	Response	Functions
7	"T" (Table)	"N" (kNee)	X1 + Y1 + X2 + Y2	ACK	(X1, Y1) coordinate for knee 1 X1, Y1, X2, Y2: "00 - FF" (X2, Y2) coordinate for knee 2
		"M" (Gamma)		ACK	
		"L" (Linear)		ACK	
		"C" (Switch A, B Table)	"0" or "1"	ACK	
8	"N"	"0" (Normal)		ACK	Normal Scan Formal
		"3" (Binning)		ACK	Double Speed Binning

Note: One byte of data consists of two ASCII codes. For example, 0x3A is "3" (0 x 33) and "A" (0 x 41). <ACK> is 0 x 06. <NAK> is 0 x 15. <CR> is 0 x 0D.

Note: 1-byte data is represented in 2 ASCII characters, e.g. 0x3A is "3A" or 0x3341.

<CR> = 0x0D *Command or response terminator*
<ACK> = 0x06 *Command accepted*
<NAK> = 0x15 *Command not accepted*

RS Command: RR<CR>
RS Return: RR + "16 bytes" + <CR>

TABLE 2. 16 Bytes Status Report

Byte 1	MGCL (1 byte)	--	CDS Gain
Byte 2	Vtop(1 byte)	--	A/D reference voltage Top
Byte 3	Vbtm(1 byte)	--	A/D reference voltage Bottom
Byte 4	XA1 (1 byte)	--	X-Coordinate of right knee for table A
Byte 5	YA1 (1 byte)	--	Y-Coordinate of right knee for table A
Byte 6	XA2 (1 byte)	--	X-Coordinate of right knee for table A
Byte 7	YA2 (1 byte)	--	Y-Coordinate of right knee for table A
Byte 8	XB1	--	X-Coordinate of left knee for table B
Byte 9	YB1	--	Y-Coordinate of left knee for table B
Byte 10	XB2	--	X-Coordinate of left knee for table B
Byte 11	YB2	--	Y-Coordinate of left knee for table B

TABLE 2. 16 Bytes Status Report (Continued)

Byte 12	FUNCFLAG1 (1 byte)	--	function flag #1
Byte 13	FUNCFLAG2 (1 byte)	--	function flag #2
Byte 14	SHTRNUM (1 byte)	--	current shutter number
Byte 15, 16	SHTRVAL (2 byte)	--	manual/direct shutter value

TABLE 3. Function Flag Description 1

BIT	7	6	5	4	3	2	1	0
FUNCFLAG #1	Resv	Resv	Resv	Resv	SHTR2FLG	SHTR1FLG	MSEL2FLG	MSEL1FLG

SHTR2FLG (Bit3) -- 00 - (0) no shutter, 01 - (1) normal shutter
SHTR1FLG (Bit2) -- 10 - (2) direct shutter, 11- (3) async shutter

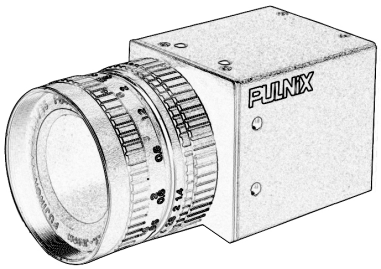
MSEL2FLG (Bit1) -- 00 - (0) normal scan, 01 - (1) partial scan #1 (optional)
MSEL1FLG (Bit0) -- 10 - (0) normal scan, #2 (optional), 11-(3) two-row scan

TABLE 4. Function Flag Description 2

BIT	7	6	5	4	3	2	1	0
FUNCFLAG #2				TSELFLG	LUTB2FLG	LUTB1FLG	LUTA2FLG	LUTA1FLG

TSELFLG (Bit4) -- 0 - Select table A, 1 - Select table B
LUTB2FLG (Bit3) -- 00 - Linear mode; 01 - Knee mode (for table B)
LUTB1FLG (Bit2) --10 - Gamma mode; 11 - Direct input mode (reserved)

LUTA2FLG (Bit1) -- 00 - Linear mode; 01 - Knee mode (for table A)
LUTA1FLG (Bit0) -- 10 - Gamma mode; 11 - Direct input mode (reserved)



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